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EPA Superfund
Record of Decision:

SUMMITVILLE MINE
EPA ID: COD983778432
OU 05
RIO GRANDE COUNTY, CO
09/28/2001

RECORD OF DECISION

FOR

SUMMITVILLE MINE FINAL SITE- WIDE REMEDY
OPERABLE UNIT 5

SUMMITVILLE MINE SUPERFUND SITE
RIO GRANDE COUNTY, COLORADO

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DECLARATION FOR THE SITE-WIDE RECORD OF DECISION

Site Name and Location

Summitville Mine Superfund Site, Summitville, Rio Grande County, Colorado.

Statement of Basis and Purpose

This document represents the final Record of Decision for the Summitville Mine Superfund site (site) final site-wide remedial action, designated as Operable Unit (OU) 5. The site is defined as the permitted 1,231-acre mine site that is located in the southeastern portion of the San Juan Mountains, in the southwest corner of Rio Grande County, Colorado. This decision document presents the Selected Remedy for the site, which was chosen in accordance with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1986, as amended by Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this site. The U. S. Environmental Protection Agency's (U. S. EPA) CERCLA identification number for the site is COD983778432.

This document is issued by the Colorado Department of Public Health and Environment (CDPHE), the lead agency for the site-wide Remedial Investigation and Feasibility Study, and the U. S. EPA Region VIII. Both U. S. EPA and the State of Colorado concur with the Selected Remedy presented herein. The remedial action selected in this Record of Decision is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances from the site into the environment.

Assessment of the Site

Past mining operations at the site resulted in contamination of surface water, groundwater, and sediments. The principal threat waste includes mobile source materials, such as acid mine drainage originating at the site, that ultimately impacts downstream waters. The acid mine drainage is also accompanied by naturally occurring acid rock drainage from mineralized terrains at the site and other areas within the Alamosa River watershed. The acidic drainage is characterized by high metals concentrations and low pH, typically below four standard units. Metal contaminants at the site include copper, iron, manganese, zinc, aluminum, and cadmium, among others. In addition, heap leach operations used sodium cyanide to extract precious metals for crushed ore. Minor amounts of residual cyanide and cyanide degradation products remain within Heap Leach Pad waste materials, and are therefore included as site contaminants.

On December 3, 1992, Summitville Consolidated Mining Company, Inc., the operator of the mine, announced pending bankruptcy and informed the State of Colorado that financial support for site operations would not continue beyond December 15, 1992. On December 4, 1992, the State of Colorado requested emergency response assistance from the U. S. EPA. On December 16, 1992, the U. S. EPA Region VIII Emergency Response Branch assumed control of the site as part of an Emergency Response Removal Action. The U. S. EPA immediately began water treatment plant modifications to treat cyanide-contaminated leachate and acid mine drainage from numerous sources at the site.

Preliminary Remedial Action Objectives were developed, to the extent practicable, in compliance with applicable or relevant and appropriate requirements to the early site cleanup actions. The site cleanup targeted five areas of primary concern for emergency response actions or interim remedial actions. Emergency response actions included plugging of the Reynolds and Chandler Adits to reduce a major source of acid mine drainage. The other areas of concern were addressed through Interim Records of Decision as described below:

- Water Treatment, designated OU0.

- Heap Leach Pad Detoxification/Closure, designated OU1.

- Excavation of mine wastes from the Cropsy Waste Pile, Beaver Mud Dump and the Cleveland Cliffs Tailings Impoundment, placement of this material in the mine pits, and mine pit closure, designated OU2.

- Site-wide reclamation activities, designated OU4.

Groundwater contamination within South Mountain was also an area of concern and originally designated OU3. An Interim Record of Decision for South Mountain Groundwater (OU3) was never drafted. Instead, groundwater concerns were addressed through the site-Wide Remedial Investigation and Feasibility Study and incorporated into the final remedy (OU5). The emergency response and interim remedial actions (OU1 and OU2) have been completed, with only minor reclamation work (OU4) remaining after the 2001 construction season. Water treatment (OU0), which is on going, has been successful at achieving Interim Action Levels established in the OU4 Interim Record of Decision for several site contaminants. However, achievement of Interim Action Levels for copper (the ecological risk driver) and aluminum has been infrequent, typically less than 10 percent of the time. In addition, State of Colorado water quality standards for the Alamosa River have been frequently exceeded over the past several years. These exceedances have been due, in part, to release of contaminated water from the site impoundment, Summitville Dam Impoundment, during years of normal or above normal precipitation. **1**

Description of the Selected Remedy

The site-wide remedial action (OU5) selected in this Record of Decision is a final action that will address the threats to the environment that remain at the site after completion of emergency and interim remedial actions. The goal of the Selected Remedy is to capture the mobile source material, (i.e., acid mine drainage), contain it in an on-site impoundment, and remove metals to achieve water quality standards in the Alamosa River. The Selected Remedy continues the benefits achieved through the emergency actions and interim remedial actions and further reduces and controls threats to the environment. The Selected Remedy will maintain interim remedial actions for OU1, OU2, and OU4. The major components of the Selected Remedy include the following:

- On-site contaminated water impoundment upstream of the Wightman Fork- Cropsy Creek confluence;
- Construction of a new gravity-fed water treatment plant downstream of the contaminated water impoundment;
- Possible breach and removal of the existing Summitville Dam Impoundment;
- Construction of a sludge disposal repository;
- Upgrade of Wightman Fork Diversion;
- Upgrade of select site ditches;

1 Several sources of acid mine drainage present at the site are not addressed by the Interim Records of Decision. The combination of inadequate storage and treatment capacity with these acid mine drainage sources, necessitate additional remedial action to further stabilize the site and to meet water quality goals in the Alamosa River and Terrace Reservoir.

- Construction of groundwater interceptor drains;
- Construction of a Highwall ditch;
- Rehabilitation of Reynolds Adit;
- Management of mine pool water;
- Continued site maintenance, and groundwater/surface water and geotechnical monitoring on-site; and
- Surface water, sediment, and aquatic life monitoring in Alamosa River and Terrace Reservoir.

Determination of impoundment size, and exact location and capacity of the water treatment plant are deferred to the Remedial Design phase. The data to support design of these two components will be collected and evaluated during 2002 and 2003. Additional data collected during the Remedial Design phase will be used to assess the success of OU4 reclamation in neutralizing acid mine drainage at the site. Design of hydraulic structures will conform to the design event (100-year snow melt and 500-year, 24-hour duration precipitation). The volume of water from the 100-year snow melt drives the sizing of the impoundment, whereas design of ditches is driven by the 500-year precipitation. Institutional controls, other than continued restricted access to the site, are not components of the remedy.

Release of contaminated water from the Summitville Dam Impoundment during springtime snow melt runoff has been necessary during years of average or greater snow pack because the combined storage and treatment capacity of the existing impoundment and water treatment plant is exceeded. The releases have immediate, detrimental impacts to the downstream environment by lowering the pH of Wightman Fork for weeks and adding a considerable metal load to the Alamosa River system. The Selected Remedy includes a new water treatment plant that employs a proven and effective active water treatment technology. A more reliable influent delivery system will be constructed that requires low levels of operation and maintenance, and could be operated year-round if necessary. The combination of a new water treatment plant, reliable influent delivery system, and storage impoundment should eliminate releases of contaminated water. The remedy also includes water diversions designed to route clean water from reclaimed areas around the treatment system, and measures to control or mitigate contaminated water from source areas that remain after site-wide reclamation (OU4) is completed.

It is expected that these actions, when implemented in total, will result in attaining the Remedial Action Objectives of restoring aquatic life use classifications and water quality in Segment 3c of the Alamosa River and below.

Statutory Determinations

The Selected Remedy meets the mandates of CERCLA § 121 and National Contingency Plan. The remedy is protective of human health and the environment. It complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, except for certain State surface water quality standards and surface water use designations that are waived in accordance with 40 CFR 300.430 (f)(1)(ii)(c). The Selected Remedy will require waiver of three numeric standards and use designation for Alamosa River Segment 3b (mouth of Wightman Fork to Town of Jasper) and the use designation for Segment 6 (Wightman Fork). Technical impracticability is the statutory basis for these waivers (CERCLA § 121(d)(4)). The Selected Remedy is cost-effective and utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable. The remedy also satisfies the statutory preference for treatment as a principal element of the remedy, in that the combination of impoundment and water treatment reduces the toxicity, mobility, and volume of hazardous substances. Because this remedy will result in hazardous substances remaining on site above levels that allow for unlimited use and unrestricted exposure, five-year statutory reviews will be conducted. The first five- year review was completed on August 3, 2000, based on the start of the first interim remedial action at Summitville. Future reviews will be conducted every five years after this initial review.

The following information is included in the Decision Summary Section of this Record of

Decision. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations (Section 2.7).
- Baseline risk represented by the chemicals of concern (Section 3.0).
- Identification of ARARs (Section 4.0).
- Estimated capital, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 7.0).
- Key factor(s) that led to selecting the remedy (Section 7.1).
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and Record of Decision (Section 7.4).
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy (Section 7.4).
- Cleanup levels established for chemicals of concern and the basis for these levels (Section 7.4.1).
- Waiver of ARARs (Section 8.2).

Max Dodson
Assistant Regional Administrator
Office of Ecosystem Protection and Remediation
U. S. Environmental Protection Agency, Region VIII

September 28, 2001

Doug Benevento
Director of Environmental Programs
Colorado Department of Public Health and Environment

September 28, 2001

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List of Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
CCR	Code of Colorado Regulations
CDPHE	Colorado Department of Public Health and Environment
COC	Chemical of Concern
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
gpm	gallons per minute
HI	Hazard Index
HQ	Hazard Quotient
MCLs	Maximum Contaminant Levels
ug/L	micrograms per liter
mg/L	milligrams per liter
NCP	National Contingency Plan
O&M	Operation and Maintenance
OU	Operable Unit
ppb	parts per billion
ppm	parts per million
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
SCMCI	Summitville Consolidated Mining Company, Inc.
SEO	State Engineer’s Office
SDI	Summmitville Dam Impoundment
TCLP	Toxicity Characteristic Leaching Procedure
U.S. BOR	U. S. Bureau of Reclamation
U.S. EPA	U. S. Environmental Protection Agency
WTP	Water Treatment Plant

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SUMMITVILLE MINE SUPERFUND SITE
RIO GRANDE COUNTY, COLORADO

DECISION SUMMARY

1.0 SITE DESCRIPTION AND BACKGROUND

The Summitville Mine Superfund Site (site) is located in the southeastern portion of the San Juan Mountains, in the southwest corner of Rio Grande County, approximately 60 miles west of Alamosa, Colorado (Figure 1-1). The site is defined as the permitted 1,231-acre mine site that covers most of Section 30 and the northern one-third of Section 31, Township 37 North, Range 4 East, of the 6th New Mexico Principal Meridian. The site is located within the San Juan mountain range of the Rocky Mountains, approximately two miles east of the Continental Divide.

Surface water (both treated and untreated) from the site ultimately drains to Wightman Fork, and then flows approximately five miles downstream to the confluence of the Alamosa River. The Alamosa River flows past the town of Jasper into Terrace Reservoir. Terrace Reservoir was constructed in 1911 as an irrigation reservoir; that remains its primary function today. Water released from Terrace Reservoir is used for livestock watering, agricultural irrigation, and wildlife habitat. Important crops grown using Alamosa River water include alfalfa, barley, wheat, and potatoes. The Alamosa River feeds wetlands that are habitat for aquatic life and migratory waterfowl. Below Terrace Reservoir, the Alamosa River flows through Capulin and terminates at its final point of diversion. The Alamosa River is non- tributary to the Rio Grande.

The ores targeted by the site were historically mined via underground methods for the recovery of precious metals such gold and silver, and copper to a lesser extent. Adits were driven into South Mountain for haulage of ore, drainage, and ventilation purposes. This underground mining activity resulted in a network of underground workings that are connected, either directly through raises, winzes, crosscuts, etc., or indirectly via fractures, faults, etc. In 1984, large-scale, open-pit mining began at the site. The open-pit mining operations used cyanide heap leaching to extract precious metals from the ore after it was placed on a heap leach pad.

Features and structures from the period of open-pit mining predominate the landscape. Site features are shown on Figure 1-2. One of the most noticeable features is the Highwall. The Highwall is a steep face of South Mountain that was created by open-pit mining. The mining exposed mineral rich, sulfide bearing rock that is a source of acid mine drainage. Acid mine drainage results when sulfide mineral-bearing rock is exposed to oxidizing conditions through man-made activities, such as blasting, tunneling, stripping, crushing, grinding, etc. Acid rock drainage results when sulfide in mineral-bearing rock is exposed to oxidizing conditions through natural weathering processes. Both processes are characterized by surface waters or groundwaters having low (acidic) pH. The former North and South open-pit mines were located at the base of the Highwall; both pits have been backfilled, capped, and contoured. The Heap Leach Pad was constructed in the Cropsy Creek valley, east of the former mine pits. The Heap Leach Pad has been capped and revegetated. The Summitville Dam Impoundment (SDI), located near the downstream boundary of the site, is used to store contaminated water for treatment. Other notable site features include the Beaver Mud Dump, North Waste Dump, water treatment plant (WTP), and the Reynolds and Chandler Adits.

The State of Colorado is the lead agency for Operable Units 4 and 5 at the site, with primary responsibilities for site cleanup being delegated to the Colorado Department of

Public Health and Environment (CDPHE). U. S. EPA Region VIII is the support agency for OU 4 and 5, but has been the lead agency responsible for emergency response and interim remedial actions (OU0, OU1, and OU2) since taking over the site in December 1992. The CERCLIS identification number for the site is COD983778432. Cleanup actions to date have been funded by the Superfund trust fund, the State of Colorado, and settlement funds. The Selected Remedy presented in this Record of Decision will be partially funded by monies received from settlements with the past operators of the mine.

1.1 ***Site History and Enforcement Activities***

1.1.1 Mining History

Placer gold was discovered in Wightman Fork downstream of the present day Summitville Mine site in the summer of 1870. The source lode deposit was found on South Mountain in 1873, and miners established open cut workings on South Mountain by 1875. The target ore of these early mining operations consisted of native gold in placers and in vein quartz. The vein quartz was associated with iron oxides, which together, comprised the surficial, oxidized zone of the deposit. Early miners drove adits and shafts into the veins to access these deposits.

There was only minor production in the, mine area from 1890 to 1925. However, the Reynolds Adit (Figure 1-2) was driven during this period. The objective in driving the Reynolds Adit was twofold: (1) to serve as an ore-haulage adit for the upper workings, and (2) to dewater the upper workings, thereby facilitating mining. The Reynolds Adit is the lowermost adit in South Mountain. A significant gold find occurred on South Mountain in 1926, sparking renewed activity in the district.

In 1934, a 100-ton-per-day flotation/cyanidation mill and gold retort was installed at the current location of the Beaver Mud Dump, shown on Figure 1-2. The dewatering filtrate from the flotation circuit was reportedly discharged directly into Wightman Fork throughout the mid-1930s. During World War II, the U. S. Government mandated the termination of non-essential minerals mining to focus on essential minerals needed for the war effort. Gold production at Summitville ceased in response to the mandate and, from 1943 to 1945, a high-grade copper vein found in the Narrow Gauge and Reynolds Adits was developed. In 1949, water discharging from the Reynolds Adit reportedly ranged from 100 to 200 gallons per minute (gpm).

From 1950 to 1984, the South Mountain area was the target of several exploration and underground improvement programs. Copper, gold, and silver were sporadically produced during this period. As part of a program to extract copper from ore in the late 1960s to early 1970s, Wightman Fork was diverted from its original route to the north, and the Cleveland Cliffs Tailings Pond was constructed (later modified and renamed the Summitville Dam Impoundment, or SDI).

During the most recent mining operations (1984 through 1992), Summitville Consolidated Mining Company Incorporated (SCMCI) developed the South Mountain mineral reserves as a large tonnage, open pit, heap leach gold mine. Galactic Resources, Inc. was the parent company of SCMCI. During this period, SCMCI mined approximately 10 million tons of gold and silver bearing ore, which was subsequently crushed and placed onto a constructed clay and synthetic lined Heap Leach Pad. A dilute sodium cyanide solution was applied to the crushed ore on the Heap Leach Pad to leach out gold and silver. After percolating through the crushed ore, the pregnant solution was pumped from a series of recovery sumps completed in the lowermost portions of the Heap Leach Pad. The pregnant solution was subsequently pumped to a metals recovery plant, where gold and silver was removed from the solution with activated carbon. The effluent, or barren solution, , was rejuvenated by restoring the target cyanide level and adjusting the pH, and then recycled through the Heap Leach Pad. Gold and silver were stripped from the carbon, precipitated from the stripping solution, smelted and sold.

1.1.2 Enforcement Activities

In October, 1984, SCMCI's parent company, Galactic Resources, Inc. obtained a mine permit for a full-scale open pit and heap leach operation from the Mined Land Reclamation Division (now the Division of Minerals and Geology). Construction on the Heap Leach Pad commenced in 1985, continued through the winter, and was completed during the summer of 1986. Numerous difficulties were experienced while constructing the Heap Leach Pad through the winter months, including several snow avalanches that damaged the pad liner. The Heap Leach Pad was originally designed as a zero-discharge facility. Water balances performed during the mine design phase assumed that ore placed on the Heap Leach Pad would be separated from snow accumulations by a temporary cover during the winter. SCMCI later opted not to cover the Heap Leach Pad in the winter. Consequently, snowmelt added a significant volume of water to the Heap Leach Pad that was not included in the original water balance.

The initial application of cyanide solution to ore on the Heap Leach Pad began on June 5, 1986. Within one week (June 10), cyanide was detected in the leak detection system, an indication that the Heap Leach Pad's primary liner was leaking. There were several cyanide leaks/ spills from the pumpback system in 1987, for which both the Colorado Water Quality Control Commission and the Mine Land Reclamation Board issued Notice of Violations.

When SCMCI began placing waste rock in the Cropsy Waste Pile upstream of the Heap Leach Pad, excess acid mine drainage generated in this area was also added to the Heap Leach Pad. This addition not only added to the growing water imbalance problems, but the acid mine drainage chemistry impacted the efficiency of the cyanide leaching process. Consequently, metals recovery suffered.

With all the additional water inputs to the Heap Leach Pad, SCMCI was forced to change its operation from that of a zero-discharge to a discharging facility. In May, 1989, the Water Quality Control Division approved SCMCI's discharge permit for a water treatment plant designed to treat contaminated water from the site, and to discharge the effluent to Wightman Fork. Because the water treatment plant could not adequately treat the volume of water to the standards required by the Water Quality Control Division permit, SCMCI received approval from the Mine Land Reclamation Division and the Water Quality Control Division to land apply contaminated water on-site. In a July, 1990 inspection of the site, the Water Quality Control Division discovered that the land application system was resulting in overland flow of land applied fluids into Wightman Fork. In February, 1991, after monitoring rising concentrations of cadmium, copper, zinc, and cyanide in Wightman Fork, the State of Colorado cited SCMCI for violations of water quality rules and regulations for discharging without a permit and issued a Cease and Desist Order to SCMCI. A Remedial Measures Plan was developed as a result of this order. A number of Notice of Violations were issued throughout 1991 and 1992 for a variety of permit violations. At this time, fish kills in the Alamosa River were reported.

On December 3, 1992, SCMCI announced pending bankruptcy and informed the State of Colorado that financial support for site operations would not continue beyond December 15, 1992. On December 4, 1992, the State of Colorado requested emergency response assistance from the U. S. EPA. On December 16, 1992, the U. S. EPA Region VIII Emergency Response Branch, as part of an Emergency Response Removal Action, assumed control of the site. The U. S. EPA immediately began water treatment plant modifications to treat cyanide-contaminated leachate from the Heap Leach Pad and acid mine drainage from the French Drain Sump, Cropsy Waste Pile, and Reynolds Adit.

Site operation oversight was undertaken by the U. S. Bureau of Reclamation (U. S. BOR) under an inter-agency agreement with the U. S. EPA. In December, 1992, Environmental Chemical Corporation, under the direction of the U. S. BOR, began conducting an engineering evaluation and subsequently began modifications to water treatment processes and facilities.

The site was added to the Superfund National Priorities List on May 31, 1994. Since the U.S. EPA takeover of the site, the State of Colorado, Division of Mining and Geology, CDPHE Water Quality Control Division and Hazardous Materials and Waste Management Division have participated in joint reviews and planning related to the interim remedial actions implemented at the site. In 1996, the U. S. EPA began transferring lead for certain work at the site to CDPHE. These lead activities include the site-wide reclamation (OU4), Remedial Investigation/Feasibility Study and Remedial Design/Remedial Action (OU5), and other remedial investigations.

On December 22, 2000, the United States Department of Justice and the State of Colorado announced that they had reached a settlement with Robert M. Friedland, the former President and Chief Executive Officer of Galactic Resources, Ltd. The settlement provides for Mr. Friedland to pay a total of $27,750,000, with $5,000,000 going to natural resource damages, and the remainder to CDPHE and U. S. EPA for future remediation and operation and maintenance at the site. The settlement agreement was approved by the United States District Court in June 2001.

1.2 Community Participation

The community has participated in emergency and interim actions since the U. S. EPA took over the site in 1992. Community participation in the Remedial Investigation Feasibility/ Study (OU5) process for the site began in 1998. In March 2000, a public meeting was held to discuss preliminary results of the Remedial Investigation. The meeting also served to notify the community of the objectives and statutory requirements of the CERCLA Remedial Investigation/ Feasibility Study process, the anticipated schedule for completing the Feasibility Study, and issuing the Proposed Plan and final Record of Decision.

Stakeholder participation directly influenced the development of remedial alternatives. The Summitville stakeholders include the following groups:

- Technical Assistance Group,
- Alamosa Riverkeepers,
- Terrace Reservoir Irrigation Company,
- Representatives of Robert Friedland,
- Division of Water Resources, and
- U. S. Forest Service.

At subsequent meetings, stakeholders were asked to identify their preferred components for the final remedy of the site. In April 2001, a community meeting was held to discuss the remedial alternatives that were presented in the draft Feasibility Study report (Rocky Mountain Consultants, Inc., 2001b). Community and stakeholder comments on the draft Feasibility Study report were solicited, and the report was subsequently revised to address these comments. Both draft and final reports for the Remedial Investigation and Feasibility Study were made available to the public (Rocky Mountain Consultants, Inc., 2001c; and Rocky Mountain Consultants, Inc., 2001d). The reports can be found in the Administrative Record for the site and are located in information repositories at U. S. EPA Region VIII Superfund Records Center and CDPHE Records Center, the Public Library in Del Norte, Colorado, and the Conejos County Natural Resources Conservation Service, in La Jara, Colorado.

On June 8, 2001, the Proposed Plan for the site was released to the public. The public comment period was from June 13 through July 11, 2001. The public comment period was later extended to August 10, 2001 at the request of a community member. A Public Meeting was held on June 20, 2001 in the San Luis Valley to discuss the Proposed Plan. The meeting was used as a forum to describe the preferred remedial alternative for the final site-wide remediation, goals of the final remedy, need for waiver of select water quality standards and use designations in certain segments of the Alamosa River, long-term monitoring, and statutory five-year reviews. An additional meeting was held on August 10, 2001 in Denver, Colorado with three stakeholder groups that requested an audience with CDPHE and U. S. EPA managers. The purpose of both meetings was to further discuss important community concerns. Stakeholder and community comments on the Proposed Plan were recorded at both meetings and are available in the Administrative Record. Responses to the comments received at the Public Meeting and comments on the Proposed Plan are included in the Responsiveness Summary, which is part of this Record of Decision.

1.3 Scope and Role of Operable Unit or Response Action

1.3.1 Past Emergency Response and Interim Remedial Actions

The immediate risk that needed to be abated by the U. S. EPA in December 1992 was the potential for contaminated water to overtop the Heap Leach Pad's Dike No. 1. A breach of this dike would have resulted in a release of metals-bearing cyanide solution to Cropsy Creek, Wightman Fork, and the Alamosa River. Sufficient water storage and water treatment capacity were not present on site to handle the volume of acid mine drainage issuing from these sources, particularly during the spring snow melt periods. Thus, plans were developed to plug the Reynolds Adit, to upgrade the water treatment facilities, and to upgrade the existing impoundment and dam.

Numerous, large accumulations of waste rock, ore stockpiles, and tailings were present at several locations throughout the site. The open-pit mines, which exposed high sulfide content ore and country rock to the atmosphere, served as focused groundwater recharge basins that funneled acid mine drainage to the Reynolds Adit system and adjacent highly fractured and faulted mineralized bedrock.

Five areas generating large amounts of acid mine drainage were the primary areas of concern during the emergency and interim remedial actions. The annual copper load (calculated by multiplying a concentration by flow rate) from the five areas was estimated to be 321,000 pounds in 1991 (U. S. EPA, 1995c). The estimated copper loads from these areas in 1991 were:

- Reynolds Adit - 143,000 pounds (44.5 percent of the site load);
- Cropsy Waste Pile - 33,400 pounds (10.4 percent of the site load);
- Heap Leach Pad or "overflow potential"- 84,000 pounds (26.2 percent of the site load);
- French Drain Sump - 14,600 pounds (4.5 percent of the site load); and
- Cleveland Cliffs Tailings Impoundment and Beaver Mud Dump - 17,000 pounds (5.3 percent of the site load).

Other areas throughout the site were estimated to contribute approximately nine percent of the site's 1991 copper load, or 29,000 pounds.

A Proposed Plan for the four interim actions at the site was released to the public in August, 1994. Preliminary remedial objectives for the interim actions to be implemented at the site were established in the 1994 Proposed Plan. These preliminary remedial objectives were developed in consideration of the then current regulatory guidelines and compliance with applicable or relevant and appropriate requirements (ARARs). The preliminary remedial objectives for the site were:

- Reduce or eliminate deleterious quality water flow from the site into Wightman Fork;
- Reduce or eliminate the need for continued expenditures in water treatment;
- Reduce or eliminate the acid mine/ acid rock drainage from the manmade sources;
- Reduce or eliminate any human health or adverse environmental effects from mining operations downstream from the site, to include the Alamosa River; and
- Encourage early actions and acceleration of the Superfund process.

Five "*primary areas of concern at the site*" for emergency response actions or interim remedial actions were targeted. Emergency response actions included plugging of the Reynolds and Chandler Adits. The other five areas of concern were addressed through

Interim Record of Decisions as described below:

- Water Treatment, (OU0, U. S. EPA, 1995a).
- Heap Leach Pad Detoxification/ Closure, designated (OU1, U. S. EPA, 1995b).
- Excavation of mine wastes from the Cropsy Waste Pile, Beaver Mud Dump and the Cleveland Cliffs Tailings Pond, placement of this material in the mine pits, and mine pit closure, designated (OU2, U. S. EPA, 1995c).
- South Mountain groundwater, (OU3).
- Site-wide reclamation activities, (OU4, U. S. EPA, 1995d).

The emergency response/interim remedial actions implemented by the U. S. EPA at the site are in various stages of completion. The following summarizes the status for each.

- Reynolds/Chandler Adit Plugging - This work is completed and is currently in the monitoring phase. As anticipated, plugging of the adits has caused some increase in seepage downgradient of the mine pits. However, the plugging has been effective in reducing the direct copper load issuing from underground workings by 93 percent as compared to the copper load measured in 1991.

- Water Treatment (OU0) - Consolidation of water treatment into a single facility was completed in 1999; however, water treatment continues with on- going efforts to improve efficiency. Water discharged from the WTP to Wightman Fork is required to meet certain effluent standards based on a seven-day consecutive average. The effluent standards apply to copper, iron, manganese, and pH. During the 1999 and 2000 operational seasons, requirements for manganese, iron, and pH were very seldom exceeded. Requirements for copper were achieved most of the time. Approximately 99 percent of the influent copper is removed by the WTP. Similar high removal percentages were achieved for iron, while manganese is slightly lower. Operation of the WTP will continue until the remedy selected in this Record of Decision is operational.

- Heap Leach Pad Detoxification/Closure (OU1) - Detoxification of cyanide in the Heap Leach Pad was accomplished through a rinsing program in 1994 and 1995. Comparison of pre- and post-rinsing concentrations indicates that the rinsing program has removed 98 percent of the liquid-phase cyanide from the Heap Leach Pad. The Heap Leach Pad was capped during the 1997 and 1998 construction seasons, and vegetated. Recent monitoring of groundwater downgradient of the Heap Leach Pad indicates that cyanide is not migrating off the site via a groundwater pathway. Minimal groundwater enters the Heap Leach Pad through the bottom liner and minimal, if any, water enters the Heap Leach Pad though its cap. Monitoring devices are in place to detect possible future movement of the downstream Dike No. 1. This operable unit is complete and it will be maintained by the final remedy selected in this Record of Decision.

- Excavation of Cropsy Waste Pile, Beaver Mud Dump, and Cleveland Cliffs Tailings Pond/ Mine Pit Closure (OU2 - The mine waste materials in the Cropsy Waste Pile, Beaver Mud Dump, and the former Cleveland Cliffs Tailings Pond have been excavated, placed in the mine pits, and the pits have been capped. With the complete removal of the Cropsy Waste Pile, the potential for acid mine drainage generation from waste rock materials in the Cropsy Basin adjacent to the Heap Leach Pad has been minimized. Data collected in 1999 and 2000 indicate that the Cropsy Waste Pile removal has reduced metals loading from this portion of the site. However, the former Cropsy Waste Pile is not wholly removed from contact with the environment. Placement of these materials in the mine pits, which are in contact with groundwater during a short portion of the year, may result in some loading to the groundwater system. This operable unit is complete and it will be maintained by the final remedy selected in this Record of Decision.

- South Mountain Groundwater (OU3) - This non-time critical removal action consisted of characterizing the hydrogeology of South Mountain groundwater. Operable Unit 3 was incorporated into the site-wide Remedial Investigation/Feasibility Study in the late 1990s, and is addressed as part of OU5.

- Site-Wide Reclamation (OU4) - Site-wide reclamation was implemented in multiple phases over several years, with major earthwork expected to be completed in 2001. Initial phases of revegetation are continually evaluated, and if needed, some areas may be re- vegetated. Though OU4 will be completed in 2002, reclamation and revegetation success will continue to be monitored and assessed under OU5. The overall effectiveness of reclamation efforts, as measured by improvements to surface water quality, is not known at this time and it may take several years before sufficient data have been collected to judge the success. This interim operable unit will be maintained by the final remedy selected in this Record of Decision.

1.3.2 Role of this Record of Decision

Operable Unit 5 is the final, site-wide remedial action for the Summitville Mine site. It identifies remedial actions to be taken within the permitted 1,231-acre mine site. It does not provide for any remedial actions to be undertaken at areas beyond the original mine site boundary. The major sources of acid mine drainage at the site have been addressed either through emergency response actions or implementation of interim remedial actions, as previously discussed. These actions resulted in significant water quality improvement downstream of the site in the Alamosa River and Terrace Reservoir. Releases of acid mine drainage to Wightman Fork, however , still occur resulting in exceedances of water quality standards and impact to the quality of downstream waters. Most significant are controlled releases that have been made from the SDI during the spring snow melt when the runoff exceeds the storage capacity of the SDI (releases have occurred in four of six years since the SDI became fully operational). The site-wide remedy presented in this Record of Decision will address these releases of contaminated water, as well as other sources of acid mine drainage remaining at the site. The goal of the final remedy is to meet State water quality standards in the Alamosa River Segment 3c downstream of the Town of Jasper. By achieving this goal, the adverse risk to the ecosystem of the Alamosa River will be minimized.

2.0 SITE CHARACTERISTICS

This Section of the Record of the Decision describes a conceptual model of the site and downstream areas. Site features, contaminant sources, chemicals of concern, and land uses are also discussed.

2.1 Conceptual Site Model

A Baseline Human Health Risk Assessment (Morrison Knudsen Corporation and ICF Kaiser Engineers, 1995a), Tier 1 Ecological Risk Assessment (Morrison Knudsen Corporation, ICF Kaiser Engineers, Inc., 1995b), and Tier 2 Ecological Risk Assessment (CDM Federal Programs, 2000) have been conducted for the site and downstream study areas. The Baseline Human Health Risk Assessment was based on data collected through 1994, while the Tier 2 Ecological Risk Assessment was based on data collected through 1997. Water quality has improved markedly since these assessments were performed. In the risk assessment process, a conceptual model of the site and offsite areas was formulated. Five exposure areas were identified for assessment of human health risks (Figure 2-1). Area 1 represents the site. Areas 2 through 5 were identified as offsite and within the study area, with each being progressively further downstream from the site. Exposure areas for ecological risk assessment were the same, except a new Area 3a was added which represented the Alamosa River upstream of Wightman Fork, and Area 3 was further divided into Area 3b, Alamosa River from Wightman Fork to Fern Creek, and Area 3c, Alamosa River from Fern Creek to the inlet of Terrace Reservoir.

A conceptual site model based on the exposure areas is shown on Figure 2- 2. The model illustrates contaminant sources, affected media or pathway, and potential human and environmental receptors. The following briefly discusses these for each of the exposure areas.

2.1.1 Area 1 - On-Site

Several sources of mine-related contamination continue to be present at the site. The largest source (by metal load) is the bedrock aquifer and underground workings (mine pool). The next largest source is water stored in the SDI. The volume of contaminated water in the SDI fluctuates through the year, depending on spring runoff, precipitation, and treatment rate. Another source of contaminated water is the Heap Leach Pad. The Heap Leach Pad contains low-level cyanide solutions, and to a lesser extent dissolved metals. Other sources of contaminated water include the runoff from the Highwall, seepage from mineralized terrains, and unreclaimed roads.

Surface water is the principal transport medium for contamination from the site. Surface water is contaminated primarily by acid mine drainage, and to a lesser extent acid rock drainage from mineralized terrains. Contaminated surface water is almost always acidic (pH generally between 2.5 and 4). Metals concentrations in surface water at the site vary, but are almost always elevated. Areas where contaminated surface water flows into Wightman Fork include seepage from a wetland area north of the North Waste Dump and seepage from SDI embankment. Releases of contaminated water from the SDI in the springtime also impact Wightman Fork and Alamosa River. Suspended solids carried by surface water are another contaminant media.

Contaminated groundwater occurs in the bedrock aquifer, colluvium, and in fill/waste rock/processed ore. Contamination in the bedrock aquifer is a result of acid mine drainage, but some of the contamination is due to naturally occurring acid rock drainage. Greatest metal concentrations are detected at the mine pits, where the water is acidic, having values of pH from 2.3 to 3.5. Contamination in the shallow colluvium is primarily from acid mine drainage derived upgradient of the colluvium. Contamination from acid rock drainage also impacts the colluvium where mineralized terrains occur. Cyanide-contaminated water exists within the Heap Leach Pad, but it has not recently been detected in monitoring wells downgradient of the Heap Leach Pad. Metals contaminated groundwater discharges to Wightman

Fork primarily through the surficial colluvium. Available data indicate that groundwater contamination does not extend beyond the mine permit boundary.

Contaminated soils are a result of acid mine drainage. The soils are highly mineralized and acidic. Operable Unit 4 reclamation activities are expected to greatly reduce risks posed by on-site soils.

Air may transport site contaminants. The primary air contaminant of concern at the site is hydrogen cyanide that could originate from the Heap Leach Pad. Cyanide readily volatilizes when exposed to air and acidic water. However, this condition is unlikely to occur because the Heap Leach Pad has been capped, a residual concentration of less than 10 milligrams per liter (mg/L) of cyanide remains, and the cyanide-contaminated water within the Heap Leach Pad is not acidic. Therefore, airborne risk from cyanide is considered minimal. Air transport of metals-bearing soils and dust from the site is not currently a concern, but any such releases will continue to decrease as reclamation activities continue.

Workers and trespassers are the populations with potential for exposure at the site. On-site work is conducted in accordance with applicable Occupational Safety and Health Administration and CERCLA regulations. Thus, an on-site worker's exposure will be minimal and will be regulated by task specific health and safety plans. Ecological receptors include aquatic organisms, wildlife, plants, and livestock.

2.1.2 Area 2 - Wightman Fork from Site Boundary to Alamosa River

The source of contamination in Area 2 is surface water originating at the site. Minimal, if any, contamination is contributed from groundwater underflow. Surface water in this area flows approximately five miles to the confluence with Alamosa River. Surface water exiting the site carries metal-contaminant loads that precipitate onto sediment surfaces. This release is evidenced by the staining or coating visible on rocks along the banks of the creek. Some of these sediments may re-dissolve as the acidity of the water changes. During the summer months, the pH of the water is generally between 4 and 5, due to acidic drainage from the site that is not captured and treated. The pH is higher (between 5 and 6.5) during fall, winter, and spring. The resultant metals load in this area directly reflects remedial actions and reclamation activities at the site.

This area has limited potential for exposure of humans to contaminants that have migrated offsite. Therefore, recreational users were judged to be the population of concern. Due to the steep terrain within the area, residential use is unlikely. Ecological receptors include aquatic organisms, wildlife, plants, and livestock. The segment has no designated human or aquatic uses.

2.1.3 Area 3a - Alamosa River Upstream of Wightman Fork

This area is not impacted by the Summitville Mine. The source of contamination in this area is from acid rock drainage from naturally occurring mineralized terrains. To a lesser extent, contamination is contributed from small abandoned mines unrelated to the site, namely the Pass-Me-By Mine and Asiatic Mine. Contaminants enter the Alamosa River primarily from three tributaries, Iron, Alum, and Bitter Creeks. These tributaries (as their names suggest) contribute acidity, aluminum, and iron to the Alamosa River.

Contaminated media in this area primarily consists of surface water. Groundwater and sediments are impacted to a lesser extent from the interaction with surface water.

Area 3a was not evaluated for human health risks, only for ecological risks. Ecological receptors include aquatic organisms, wildlife, plants, and livestock.

2.1.4 Areas 3b and 3c - Alamosa River from Wightman Fork Confluence to Terrace Reservoir

A source of contamination in these areas includes acid mine drainage from the site that enters the river via Wightman Fork. Naturally occurring acid rock drainage originating from upstream tributaries including Alum, Bitter, and Iron Creeks, as well as minor acid mine drainage, further contribute to the degradation of water quality in Areas 3b and 3c. Additional, relatively minor sources of contamination along these reaches of the Alamosa River include naturally occurring drainage and acid mine drainage from mineralized terrains in the vicinity of Jasper.

Contaminated media consists of surface water and sediments. Groundwater may be impacted from the interaction of surface water and groundwater. Groundwater contamination, if present, is likely limited to the alluvium along the Alamosa River.

Areas 3b and 3c have both campgrounds and residences within their boundaries. A summer camp facility is located along the Alamosa River for older youths who typically enroll for a one-week period during the summer. There are several seasonal residents within the Town of Jasper and one to two individuals who are year-round residents. The receptors in this area are juveniles and adults. Juveniles are considered recreational users and adults are seasonal residents of the area or staff members of the camp. Ecological receptors include aquatic organisms, wildlife, plants, and livestock.

2.1.5 Area 4 - Terrace Reservoir

The source of contamination in Terrace Reservoir is the Alamosa River, which carries contaminant metal loads from upstream areas including Wightman Fork and upper tributaries of the Alamosa River. Sediments may contribute metals to the overlying reservoir waters under some conditions. Sediments and surface water have been impacted in this area.

Terrace Reservoir provides irrigation water to the San Luis Valley. Human exposure in the area of the reservoir is unlikely because the reservoir is private property. The steep sides of the reservoir limit boating due to poor access. However, there may still be a potential for recreational use. The potential for future residential exposure in this area is remote due to the land use restrictions. Ecological receptors include aquatic organisms, wildlife, plants, and livestock.

2.1.6 Area 5 - Alamosa River Downstream of Terrace Reservoir

The source of contamination in this area is from Terrace Reservoir, which receives the contaminated water from the Alamosa River. Contaminated media include surface water and sediments.

Area 5 extends from Terrace Reservoir into the San Luis Valley where farming and irrigation activities occur. This area includes several communities with higher population densities than upstream areas. Residents are the receptors of concern for this area. Groundwater is the only media that poses a potential pathway to both child and adult residents. However, results of domestic well sampling periodically from 1993 to 2000 have documented that groundwater does not pose an adverse risk to humans. Ingestion of crops and livestock is a potential exposure route for humans. Ecological receptors include aquatic organisms, wildlife, and plants.

2.2 *Site Features*

The permitted 1,231 acre Summitville Mine contains approximately 550 acres of disturbed area, most of which is positioned on the northeastern flank of South Mountain (Figure 1-2). Elevations at the site range from 11,150 feet to approximately 12,300 feet at the highest extent of mine workings. The site is bounded by Wightman Fork and the deserted Town of Summitville to the north, Cropsy Creek to the south and east, and the mine workings of the South Mountain Highwall to the southwest (Figure 1-2). A wetland or boggy area lies between upper Wightman Fork and the mine, and is an area of historic groundwater discharge. Cropsy Creek is the major surface water drainage on the east side of the site. Cropsy Creek flows into Wightman Fork at the downstream boundary of the site.

The Summitville area experiences long, cold winters, and short, cool summers. Annual precipitation averages approximately 41 inches. Average snow fall is about 344 inches (29 feet) with snow melt runoff occurring over a relatively short period from early-May to mid-June. Protected snow banks on northern aspect slopes can persist throughout the year. Thunderstorms are common in the afternoon hours during the months of May through September and can be very intense, though short in duration. Many of the northern aspect slopes, and most of the lower slopes are heavily covered with spruce and interspersed with stands of aspen at the lower elevations of the site.

The following list constitutes the major site features discussed in Section 2.5 (Figure 1-2). Some of the features remain from the early periods of underground mining, but most resulted from the open-pit mining operations that ceased in 1992. Since cessation of mining, some site features have been altered or eliminated through emergency response actions or interim remedial actions. Additional information for each feature may be found in the Remedial Investigation Report (Rocky Mountain Consultants, Inc., 2001c).

- Highwall
- Heap Leach Pad
- North and South Mine Pits
- Summitville Dam Impoundment, formerly Cleveland Cliffs Tailings Pond
- North Waste Dump
- Beaver Mud Dump
- Cropsy Waste Pile Footprint
- Water Treatment Plant
- Cyanide Destruction Plant
- Upper Storage/Maintenance Building
- Reynolds Adit
- Chandler Adit

2.3 Archaeological and Historical Artifacts

Most of the cultural resources associated with the historic mining activities at Summitville were destroyed by the most recent open-pit mining activities. The remaining cultural sites identified by U. S. BOR (1998) at Summitville are briefly described below. These sites will not be disturbed during implementation of the Selected Remedy.

- Lower Summitville (Site 5RN358) - The historic buildings at the site date principally from the 1930s. Buildings at Lower Summitville are located north of the SDI. The Summitville Town site is northwest of Lower Summitville and not within the mine permit boundary.

- Chandler Adit (Site 5RN294) - The Chandler Adit contains a combination of modern and historic structures and artifacts. The historic structures are timber pilings and a portion of a timber trestle left standing in the mine dump. Some of the milling equipment and other debris around the Chandler Adit may be historic. The timber trestle will be preserved.

- Hannan Adit (Site 5RN546) - This site contains an adit, two claim posts found dating to 1939 with the name J. H. Hannan, and two small prospect pits. This site is not within the disturbed area of the mine.

- Cabin (Site 5RN547) - A small cabin, collapsed outhouse, collapsed shed, and a number of artifacts are located at this site.

- Chandler Boarding House (Site 5RN548) - This site is a boarding house and associated features. This site is outside the disturbed area.

- Grey Eagle Adit (Site 5RN549) - An L-shaped wooden structure lies above a road cut, just southwest of the WTP. It consists only of the wooden structure. No artifacts are present in the area.

- Equipment Artifacts - In addition to the above-described sites, there are several historic artifacts at the site. A Sterns Roger roll crusher is in the storage yard behind the upper storage building. The crusher, which is in several pieces, has a patent date of February 11th, 1896 on its metal housing. A P&H stripping shovel lies in the storage yard behind the upper storage building. The shovel appears to be at least 50 years old. An old snow plow lies in the storage yard behind the upper storage building. The plow may be 50 or more years old, but it has not been dated.

2.4 Sampling Strategy

On- site and offsite monitoring programs have been designed and implemented at the site and downstream study areas to measure the effectiveness of emergency response and interim remedial actions, to support the site-wide Remedial Investigations/Feasibility Study, and to support decision-making for selection of this final remedy. Monitoring programs are discussed below.

2.4.1 On-Site Monitoring Program

2.4.1.1 Surface Water

A monitoring program is in place for surface water at the site. Site-wide surface water monitoring has been conducted since 1993. The objectives of the program are to characterize site waters and estimate impacts (i.e., metals loads and acidity) to Wightman Fork, to evaluate areas where further investigation may be necessary, and to evaluate effectiveness of response actions and interim remedial actions. Surface water sampling locations have changed from year to year as a result of reclamation activities. At present, surface water is monitored on a weekly basis at approximately 30 locations during the field season, which typically begins in late-April and ends in late-October. Monitoring locations are shown on Figure 2-3. Water flowing from select seeps and adits are included in the surface water monitoring program.

Water samples are analyzed by U. S. EPA’s site contractor (CDM Federal Programs), who operates a laboratory at the site. Samples are analyzed for total concentrations of copper, iron, manganese, and zinc. The laboratory also analyzes water samples for weak acid dissociable cyanide. Periodic testing for cyanide is performed for samples collected downstream of the Heap Leach Pad.

2.4.1.2 Groundwater

A monitoring program is in place to monitor groundwater water quality at the site. The objectives are the same as those for the surface water monitoring program. Site-wide groundwater monitoring has been conducted since 1995. A total of 67 functional wells are currently in place at the site and available for monitoring. Locations of monitoring wells are shown on Figure 2-4. One to three site-wide groundwater sampling events have been conducted during the summer seasons over the past several years. Each event included sampling of 15 to 30 wells. The groundwater monitoring program also includes annual sampling of seeps and springs. Over 70 seeps have been identified at the site that are shown on Figure 2-5. Approximately 30 select seeps are sampled annually.

Contractors working for the CDPHE have been responsible for groundwater sampling since 1997. Groundwater and seep samples are currently tested for dissolved metals and major ions. In addition, well and seep samples collected in the Cropsy Valley are analyzed for cyanide and cyanide degradation products. Analytic testing of groundwater and seep samples is performed by an independent laboratory.

2.4.2 Offsite Monitoring Program

2.4.2.1 Surface Water

A surface water monitoring program is in place for study areas downstream of the site. Downstream study areas include Wightman Fork, Alamosa River above Wightman Fork, Alamosa River above Terrace Reservoir, Terrace Reservoir, and the Alamosa River downstream of Terrace Reservoir. The objectives of the offsite monitoring program are to:

- Monitor the effects of site remediation on downstream water quality in the Alamosa River basin within each WQCC segment,
- Obtain representative water quality data to support the site-wide Remedial Investigation/Feasibility Study efforts and to evaluate remedial actions,
- Provide water quality data to assess in-stream standards in the Alamosa River and Terrace Reservoir, and
- Obtain water quality data to support geochemical modeling activities in the Alamosa River basin and Terrace Reservoir.

Offsite surface water sampling locations are shown on Figure 2-6 and correspond to the upstream or downstream boundary of a segment, as defined in 5 CCR 1002-36. Currently, the surface water monitoring network consists of 10 locations, including three stations along Wightman Fork and six stations along the main stem of the Alamosa River. Terrace Reservoir is sampled at one location near the deepest portion of the reservoir. Some of the Alamosa River monitoring stations are equipped with instrumentation to continuously measure flow and pH.

Offsite surface water has been sampled from four to seven times a year since the current program that started in 1998. Sampling typically targets the time prior to, during, and immediately following the peak runoff. Peak runoff generally occurs in late May, but may vary by a week or so depending on snow pack and temperature during the spring. Sampling also targets monsoonal rainstorms that occur in July or August, low-flow conditions in the fall, and times when the SDI is releasing contaminated water. Surface water is synoptically sampled when and where possible.

Water samples from Terrace Reservoir are collected from the lacustrine zone where fine clay and colloidal material typically settle from the water column. A multi-probe meter is used to measure in-situ water quality parameters. The parameters are used to chemically profile the water column and determine the approximate depths of the three reservoir stratification zones (if present): epilimnion, metalimnion, and hypolimnion.
Water samples are tested for major trace metals, among other major cations.

2.4.2.2 *Sediment*

Stream sediment samples from study areas downstream of the site were collected and analyzed in 1976, 1992, 1994, and 1995. A comprehensive sampling of stream sediments was recently performed in August 2000. The objective of this latter sampling was to characterize the extent of metals contamination in stream sediments, to evaluate geochemical relationships between sediment metal concentrations and water quality, and to compare the 2000 data to historic sediment data.

During the 2000 sampling, sediment samples were collected from a total of 61 locations along Wightman Fork and the Alamosa River, in Terrace Reservoir, and downstream of Terrace Reservoir. Both in-stream and bar deposits were sampled from Wightman Fork and Alamosa River. In-stream deposits are sediments below the water. Bar deposits were collected in areas where appreciable sediment occurs which is likely to become inundated during times of high- flow.

Terrace Reservoir functions as a sediment trap where sediments transported by the river are ultimately deposited. Terrace Reservoir sediments were collected from three zones including the riverine, transition, and lucustrine zones during the 2000 sampling effort. Shoreline deposits were also sampled.

In the 2000 sampling effort, select sampling locations were additionally evaluated for aquatic life and habitat conditions in Alamosa River and Terrace Reservoir. Terrace Reservoir was also targeted to assess the sustainability of rainbow trout, which was accomplished by conducting a four-day caged fish study.

2.4.2.3 Groundwater

Offsite groundwater along the Alamosa River has been sampled on several occasions, primarily from domestic wells. Most all of the wells are completed outside of the alluvial sediments of the Alamosa River. A comprehensive assessment of groundwater quality along the Alamosa River was conducted in 1993 to develop baseline information on whether contamination had occurred. Sampling of domestic wells has also been performed in 1998, 1999, and 2000. Between 4 and 24 domestic wells have been sampled during these events.

2.5 Known or Suspected Sources of Contamination

Areas either known or suspected to be contaminated are briefly described below. Many of these areas or features are shown on Figure 1-2. Table 2-1 summarizes source areas and the nature of the contamination, e.g., the volume, discharge rate, etc. of contaminated media. A brief description of each source follows.

- Heap Leach Pad - Unlike the acidic water found at many areas of the site, the pH of the water in the Heap Leach Pad is above neutral (7.5 to 9). This pH is due to the buffering capacity of the lime that was added to the crushed ore as it was placed on the Heap Leach Pad to enhance the leaching of precious metals by cyanide. The Heap Leach Pad contains processed ore with pore fluids that contain low concentrations of cyanide and cyanide degradation products such as thiocyanate and ammonia. Dissolved metal concentrations are low, in the few mg/ L range, due to the neutral pH. At a groundwater elevation of 11,528 ft, the Heap Leach Pad contains approximately 290 acre-feet of water in the pore spaces of the processed ore.

- Summitville Dam Impoundment - The impoundment provides storage of acid mine drainage originating at the site that is conveyed via the on-site ditch system. The contaminated water is subsequently pumped from the SDI to the WTP for treatment. The volume of contaminated water in the impoundment fluctuates depending on water treatment rate, water input from source areas, and precipitation. When full, the SDI capacity s close to 275 acre-feet. The water is high in metals and has a low pH, between 3 and 4. Sediments that accumulate in the impoundment are also undoubtedly high in metals content.

- Bedrock Aquifer - The bedrock aquifer within South Mountain is high in metals and has a low pH, typically between 2.5 and 4. Poorest water quality is associated with the altered quartz latite and mineralized ore zone near the mine pits. The volume of impacted groundwater is estimated to be 147 acre-feet. Contaminated groundwater discharges to underground workings or issues from the ground as seepage at the lower elevations of the site. Groundwater contamination generally decreases at depth (i.e., below the zone of oxidation) . Groundwater contamination also decreases laterally away from the mine pits and ore zone.

- Mine Pool - The Reynolds and Chandler Adits were plugged in 1994, as part of a emergency response action, to reduce the contaminant load discharging from the lowermost Reynolds Adit. Plugging resulted in the inundation of the underground workings and created a pool of mine-impacted water. Water in the mine pool is acidic (pH of 2.5 to 3.5) and has high metals concentrations. The estimated volume of water in the mine pool (behind the Reynolds and Chandler Adit plugs) is about 14 acre-feet. The elevation of the mine pool can be regulated by releasing water from the Reynolds Adit pipeline that penetrates the adit plug.

- Adits - In the vicinity of the open pit operations, the most important adits are, from lowest to highest, the Reynolds Adit, the Chandler Adit, and the Iowa Adit. The Reynolds and Chandler Adits have been plugged. Water infiltrating downstream of each adit s plug is a source of acid mine drainage. Although water issuing from the Iowa Adit is not from the mine pool, it is also a source of acid mine drainage. The collective flow from these adits during the summer season can range from approximately 50 to 200 gpm.

- French Drain - An underdrain system was constructed by SCMCI to intercept groundwater flowing from seeps below the Heap Leach Pad. The underdrain system became contaminated with cyanide and metals leaching from the Heap Leach Pad. The water is acidic, having pH values between 3 and 4. Water from the French Drain is routed to the SDI. Flows range from about 20 gpm in the fall to 190 gpm during spring snow melt.

- Seeps - Numerous acid seeps occur at the site. These are areas where groundwater naturally comes to the surface, though some may have been the result of mining activities at the site. Major areas of seepage are found between the WTP and Chandler Groin (referred to as the Missionary Seeps area), at the toe of the North Waste Dump, a wetland area between the North Waste Dump and Wightman Fork, Beaver Mud Dump, footprint of former Cropsy Waste Pile, Dike No. 1 of the Heap Leach Pad, and the embankment of the SDI. In almost all areas, the seepage is high in metals and acidic, having pH values between 2.5 and 4. The collective seepage at the site is around 300 gpm during years when precipitation is average to above average, and decreases to about 90 gpm for years having below normal precipitation.

- Pumphouse Fault - A north-trending fault occurs in the Missionary Seeps area that is a pathway for groundwater to reach Wightman Fork. The water is high in metals concentrations, most notably copper (40 to 60 mg/L), and has a low pH typically around 3. At times of low flow in Wightman Fork in past years, the water from the fault has been responsible for a significant portion of the metals load in the creek. Flow rates range from approximately 10 to as high as 60 gpm. The flow from the fault was routed to the SDI in August 2001.

- Highwall - The Highwall is a large surface area (50 acres) of exposed, fractured sulfide-metal bearing rock. The Highwall developed as a result of the open- pit mining and runoff is a source of acid mine drainage. The Highwall will continue to produce acid mine drainage for the foreseeable future.

- Beaver Mud Dump - The dump consisted of combined metallic sulfide tailings from previous underground mining operations and overburden from open-pit mining operations. The 18-acre Beaver Mud Dump was located immediately adjacent to and south of Wightman Fork. Most all of the waste materials have been excavated and placed into the mine pits. Seepage still occurs at the Beaver Mud Dump. It is acidic and relatively high in metals content.

- North and South Mine Pits - Two large pits (North and South Pits) resulted from mining activities that occurred from 1986 through 1991. As part of the interim remedial action, approximately four million cubic yards of waste rock was placed back into the mine pits, and the pits were capped. The waste rock in the basal portion of each pit is occasionally saturated during times of seasonal high groundwater levels. At the South Pit, the time when waste rock is saturated is limited to about two weeks or less, but saturated conditions can persist for about two months at the North Pit. The saturated waste rock is a source of acid mine drainage to the bedrock aquifer, but the volume of acid mine drainage generated from the waste rock is minimal because of the limited time the waste rock is saturated.

- North Waste Dump - The dump is composed of waste rock and overburden from the mine pits. These materials contain metallic sulfides and are a potential source of acid mine drainage. The majority of the waste rock is dry except for a zone along the toe that is saturated, as evidenced by several seeps. The seepage is acidic and metals concentrations are elevated.

- Sludge Disposal Area - The existing water treatment process at the site produces a sludge that is transported to a disposal area at the South Pit. The disposal area is underlined by compacted clayey waste rock. Precipitation can interact with the sludge and waste rock, creating acid mine drainage that infiltrates into the bedrock aquifer. The sludge disposal area currently contains 20,000 cubic yards of sludge. Surface water runoff from the sludge disposal area is routed to the SDI.

- Unreclaimed Terrain - Many of the roads at the site were constructed using waste rock removed from the mine pit and from overburden and/or waste rock. These roads and other terrains consisting of mineralized rock are sources of acid mine drainage. However, all site roads remaining in place at the completion of the OU4 reclamation work are scheduled to be amended with a neutralizing agent to eliminate formation of acid mine drainage.

2.6 Types of Contamination and Affected Media

The primary type of contamination at the site is acid mine drainage. Acid mine drainage affects sediment, surface water, and groundwater at the site. Another type of contamination is acid rock drainage. Acid rock drainage also affects sediment, surface water and groundwater at the site. Both are characterized as surface waters or groundwaters having a low (acidic) pH, and generally less than standard units and elevated dissolved metals concentrations. Chemically, there is no distinction between the two. Both result from the oxidation of sulfide minerals. It is the process through which the sulfide mineral-bearing rocks are exposed to oxidation that distinguishes the two.

The oxidation of sulfide minerals, such as pyrite ($FeS2$), initially requires both air (i.e., oxygen) and water to occur. Once initiated, pyrite oxidation can proceed in the absence of oxygen using ferric iron as the oxidizing agent. The products of pyrite oxidation reactions include iron ions and sulfuric acid. In the absence of sufficient buffering capacity, the formation of sulfuric acid leads to the generation of acid mine and rock drainage. Many metals, aluminum, cadmium, copper, iron, manganese, and zinc included, are more mobile in low pH (acidic) water. Thus, the oxidation of sulfide minerals at the site provides both the source of the metals and one of the means (dissolved in surface water) to transport the metal away from the site. Metals may also be transported by surface waters in the particulate (e.g., sediment) form.

Another type of contamination at the site is cyanide. Cyanide does not naturally occur at the site, but was introduced during SCMCI’s heap leach operations. Cyanide was used to leach microscopic particles of precious metals (e.g., gold and silver) from processed low-grade ore. The form of cyanide used in these leaching operations is predominately sodium cyanide, NaCN. Once dissolved in water, sodium cyanide dissociates into sodium ions and cyanide ions. Cyanide ions readily combine with metals to form metal complexes; it is this property that the mining industry exploits in leaching operations. Because cyanide degrades in a low pH environment, an alkaline environment is necessary in heap leach operations. Thus, lime was mixed with the crushed ore as the ore was placed in the Heap Leach Pad. The resulting cyanide solutions added to the Heap Leach Pad were also strongly alkaline. Cyanide and cyanide degradation products in groundwater are limited to the Heap Leach Pad; none were detected in monitoring wells in the Cropsy Valley downgradient of the Heap Leach Pad in 1999 and 2000. Small amounts of cyanide and related compounds enter the SDI via the French Drain outfall.

2.7 Chemicals of Concern

The Baseline Human Health Risk Assessment (Morrison Knudsen Corporation and ICF Kaiser Engineers, Inc., 1995a) identified chemicals of concern (COCs) using a tiered screening approach. This approach consisted of an initial statistical screening followed by a toxicity screening for those COCs passing the first tier. For the first tier statistical screening, surface water data were divided into either a pre-SCMCI or post-SCMCI data set. These data reflected samples acquired prior to and after SCMCI began heap leach operations in June of 1986. The chemicals determined to be significantly greater than “background”(i.e., post-SCMCI concentrations greater than pre-SCMCI), as well as those without sufficient data to statistically compare, were carried over to the second tier for a toxicity screen.

The second tier toxicity screens were conducted for those chemicals passing the first tier by comparing exposure point concentrations to toxicity-based criteria. Exposure point concentrations were based on a surface water data set collected from May 1993 through September 1994 at both on-site and offsite surface water stations. Wightman Fork at the downstream site boundary (sampling station WF5.5), served as the on-site exposure point, while the sampling location at the mouth of Wightman Fork (station WF0.0), served as the offsite point. For on- site exposures, COCs were selected by comparing exposure point concentrations to acute toxicity criteria (1-day Health Advisories, where available). For offsite exposures, COCs were selected by comparing exposure point concentrations to chronic toxicity criteria ARARs and preliminary remedial action goals.

The Baseline Human Health Risk Assessment resulted in identification of the following COCs:

COC’s for On-Site Exposures (based on WF-5.5)	**COCs for Offsite Exposures (based on WF-0.0)**
Aluminum	Aluminum
Antimony	Antimony
Arsenic	Arsenic
Copper	Beryllium
Cyanide	Cadmium
Iron	Copper
Manganese	Cyanide
	Iron
	Lead
	Manganese
	Nickel
	Zinc

Environmental chemicals of concern were also identified in the Tier 1 and 2 Ecological Risk Assessments. The Ecological Risk Assessments resulted in the identification of the following COCs:

Tier 1 COCs	Tier 2 Aquatic Risk Drivers
Aluminum	Copper
Arsenic	Cyanide
Cadmium	Iron
Copper	Zinc
Cyanide	PH
Iron	
Lead	
Manganese	
Nickel	
Zinc	
pH	

2.8 Characteristics of COCs

As will be discussed in the Summary of Site Risks (Section 3.0), the primary risks posed by the site are those imparted on the aquatic life downstream of the site. Human health is not at risk. Therefore, the following discusses the characteristics of the primary risk drivers, as identified in the Tier 2 Ecological Risk Assessment. Information on COC occurrence, mobility, toxicity, and regulatory standards, where applicable, is provided.

2.8.1 Copper

Copper is present in many sulfide minerals throughout the Summitville Mining District. Aqueous copper forms strong complexes with dissolved organic matter, which can significantly enhance copper mobility. Copper complexes may actually increase copper adsorption to hydrous metal oxides at pHs less than 6, but will enhance copper mobility at higher pH. In addition to this strong affinity for organic matter, copper is strongly adsorbed by hydrous iron, aluminum, and manganese oxides in soils, sediments, or in the water column. The adsorption of copper on hydrous metal oxides is strongly pH dependent.

Aquatic organisms are extremely sensitive to copper. With the exception of two stream segments on the Alamosa River, the State of Colorado uses hardness-based equations to calculate chronic and acute water quality standards for dissolved copper. In “soft” waters (i.e., those with low concentrations of calcium and magnesium), the calculated copper standards are very low. For example, the chronic and acute copper standards for a hardness level of 100 mg/L as $CaCO_3$, which is a value typical in the Alamosa River downstream of Wightman Fork, are 12 micrograms per liter (ug/L) and 18 ug/L, respectively. However, the presence of dissolved organic carbon can decrease the toxicity of copper by forming strong organic copper complexes that render the copper less bio-available.

In the Alamosa River from Wightman Fork to Fern Creek, the chronic copper standard is “fixed” at 30 ug/L. Segments 3b and 3c have a hardness based acute standard. Mammals tolerate much higher levels of copper than aquatic life. The primary drinking water action level for copper is 1,300 g/ L, while the secondary drinking water standard is 1,000 ug/L. The State of Colorado agricultural standard for copper is 200 ug/L.

2.8.2 Cyanide

The form of cyanide used in the leaching operations at the site was predominately sodium cyanide, NaCN. Cyanide ions (CN^-) readily combine with metals to form metal complexes.

Cyanide ions react with water to form hydrogen cyanide (HCN). This reaction is pH dependent. In an aqueous solution with a pH above approximately 9.4, cyanide ions predominate. Below a pH of 9.4, hydrogen cyanide is the predominate form present. Hydrogen cyanide and cyanide ions are referred to as “free” cyanide compounds. Hydrogen cyanide will readily volatilize and is lost to the atmosphere. This degassing process is enhanced in high-energy mountain streams, where turbulence increases the water- atmosphere contact rate. Cyanide forms complexes with a variety of metal ions. The stronger the affinity for the metal, the less bio-available the cyanide is.

The decomposition rate of cyanide complexes is affected by temperature, pH, sunlight, atmospheric carbon dioxide, and other environmental factors. From an environmental standpoint, pH plays a large role in the decomposition of cyanide compounds; the lower the pH, the lower the stability of many metal-cyanide complexes. Subsurface reactions, and reactions induced through chemical treatment, result in the degradation of cyanide with the subsequent generation of a variety of cyanide- related compounds. Some of the more dominant cyanide degradation products include thiocyanate, cyanate, and ammonia.

Free cyanide is toxic to aquatic life at low concentrations. Accordingly, the State of Colorado has set the surface water quality standard for free cyanide at 5 ug/L. Mammals can tolerate higher concentrations of free cyanide. As a result, the primary drinking water standard for free cyanide is 200 ug/L.

2.8.3 Iron

At Summitville, the most geochemically important occurrence of iron is in the form of pyrite. It is the oxidation of pyrite that leads to the formation of acid mine drainage. Pyrite is concentrated in the ore-bearing zone at Summitville, but it is also distributed throughout the adjacent country rock.

Ferrous iron (Fe^{+2}) is the dominant form present under reducing conditions, whereas ferric iron (Fe^{+3}) is the dominant form of iron present in oxidizing solutions. Dissolved ferrous iron generally only persists at the surface in strongly acidic solutions. Both ferrous and ferric iron form inorganic complexes with anions in solution. Given the dominance of sulfate and low pHs in the Alamosa River basin, iron-sulfate complexes may play a significant role in iron mobility.

The dominant controls over iron in surface water draining the site are precipitation and dissolution reactions. As the pH and redox potential in a surface water body rises, ferrous iron will oxidize to ferric iron. As the pH and redox potential rises further, the ferric iron will precipitate from solution as a hydrous iron oxide. These hydrous iron oxides may be carried downstream in suspension, or they may settle to the stream substrate. If the ambient pH becomes more acidic, these hydrous iron oxides may partially or wholly re-dissolve.

The State of Colorado water quality standards for iron vary from segment to segment in the Alamosa River basin. Between Wightman Fork and Terrace Reservoir, the chronic standard for total recoverable iron is set at 12,000 ug/L; there is no standard governing dissolved iron. Within Terrace Reservoir, dissolved and total recoverable iron chronic standards are 300 ug/L and 1,000 ug/L, respectively. In the Alamosa River below Terrace Reservoir, the chronic standard for total recoverable iron is set at 1,000 ug/L; there is no standard governing dissolved iron. There is no primary drinking water standard for iron. The secondary drinking water standard, 300 ug/L, is an aesthetic standard, set because of iron’s tendency to deposit reddish-yellow stains on clothing, plumbing fixtures, and cookware. The State of Colorado agricultural standard for iron is 5,000 ug/L.

2.8.4 Zinc

Zinc is a relatively common metal. Zinc can occur as a substitute for iron and manganese in silicate minerals. Zinc is mobile in acidic and neutral aqueous solutions. Zinc is relatively mobile under oxidizing conditions, but may be precipitated as a sulfide under reducing conditions. Zinc is readily sorbed to hydrous oxides of iron and manganese, as well as to clays, and exhibits similar adsorption characteristics as copper, but at higher pHs. Divalent cations, such as calcium, will reduce zinc adsorption by competing for exchange sites Sulfate may enhance zinc adsorption.

Aquatic organisms are not as sensitive to zinc as they are to copper. For all segments of the Alamosa River, the State of Colorado uses hardness based equations to calculate chronic and acute water quality standards for dissolved zinc. In “soft” waters, the calculated zinc standards are moderately low. For a hardness level of 100 mg/L as CaCO3, the chronic and acute zinc standards are 106 ug/L and 117 ug/L, respectively. There is no primary drinking water action level for zinc, and the secondary drinking water standard is 5,000 ug/L. The State of Colorado agricultural standard for zinc is 2,000 ug/L.

2.8.5 pH

The hydrogen ion activity of a solution is referred to as pH. The pH scale ranges from 1 to 14 standard units. Solutions with pH values less than 7 are acidic and are basic above 7. The binding of a metal ion is strongly pH dependent. In addition to the actual pH value, the relative change in pH over time is also important to aquatic life. Rapid changes in pH or changes that are extreme from the normal pH values of a given water body can be detrimental to aquatic life.

In all of the main stem of the Alamosa River, including Terrace Reservoir, the State of Colorado has a fixed standard for pH of 6.5 to 9.0 standard units. One exception to this fixed standard is found at Segment 3a, which is the Alamosa River from Alum Creek to Wightman Fork. In this segment, four seasonal ranges in pH have been established as standards. The pH ranges from around 4 to 9 standard units.

2.9 Concentrations of COCs

Because conditions at the site have been improving since 1994 as a result of interim remedial actions, concentrations of COCs have likewise changed since U. S. EPA conducted its human health and ecological risk assessments. Therefore, recent data have been used to tabulate concentrations of COCs. Concentrations of COCs have been tabulated for the five exposure areas used in the Baseline Human Health Risk Assessment, which include Area 1 (on-site) and Areas 2 through 5 (offsite), as shown on Figure 2-1. Table 2-2 presents minimum and maximum concentrations of COCs, and other parameters, for surface water and groundwater. Table 2-3 presents maximum and minimum concentrations of COCs for stream sediments. The two tables are based on data collected during the 1999 and 2000 field seasons, except for groundwater concentrations in Areas 3 and 5 that are based on all available data. Additional information may be found in the Remedial Investigation Report (Rocky Mountain Consultants, Inc., 2001c).

2.9.1 Area 1- On-Site

Concentrations of COCs in site-wide surface water are summarized in Table 2-2. Concentrations are greatest in surface water runoff from the Missionary Seeps area, below the Chandler Adit, and along the toe of the North Waste Dump. These areas have historically produced some of the poorest surface water quality at the site, which is high in metals and strongly acidic (pH between 2.5 and 3.5). It is common for surface water from these areas to have total recoverable concentration of copper and aluminum around 100 mg/L, iron in the range of 500 to 1,000 mg/L, and manganese and zinc around 400 mg/L. Lowest concentrations generally occur in the spring and maximum concentrations occur in the fall. Water quality standards have not been established for on- site surface water with the exception of the WTP effluent, which has discharge standards for pH, copper, iron, and manganese.

A considerable amount of acid mine drainage at the site, other than during snow melt runoff, is from seepage. The magnitude of dissolved copper concentrations for areas of major seepage is illustrated on Figure 2-7. On Figure 2-7, circles are used to represent major seepage areas, and the size of the circles reflect the average copper concentrations for seeps in that particular area. As previously mentioned, highest copper concentrations in seepage are found in Missionary Seep area, westward to the Chandler Groin and the toe of the North Waste Dump. Lower copper concentrations are found in seepage within the Cropsy Valley.

Another measure of surface water contamination is the metals load that is carried by the surface water. A load is calculated by multiplying the metal concentration by the flow. With the appropriate unit conversions, the load is typically expressed in units of pounds per day. A loading analysis of drainage entering the SDI was performed for 1999 (Figure 2-8) and 2000 (Figure 2-9). On-site sources of acid mine drainage were consolidated and routed through various ditches to the SDI in early 1996. Since then, the SDI has served as the primary surface water storage reservoir at the site. Sampling locations and the ditch network are shown on Figure 2- 3.

Drainage from the North Waste Dump area, Missionary Seeps, and Chandler Groin, as represented by the sample location SC-7, provided the largest overall metals load to the SDI in 1999. The largest loading source to the SDI in 2000 changed to the Reynolds Adit. This change was due to two factors. First, the below average precipitation in 2000 lowered loading from surface water sources more so than from groundwater sources like the Reynolds Adit. This conclusion is supported by the similarity in average daily metals load from the Reynolds Adit in 1999 (401 pounds) and in 2000 (377 pounds). Another possible explanation for the change is that reclamation work may have reduced metal loading measured at the SC-7, MS, and L3-1 locations. However, review of 1999 and 2000 metals concentrations in these areas indicates that concentrations were similar, suggesting that the reduction in the 2000 load was primarily due to a reduction in flow caused by the below normal precipitation.

Site- wide concentrations of COCs in groundwater are summarized in Table 2-2. Maximum concentrations of COCs typically occur at the mine pits. Figure 2-10 shows dissolved copper concentrations measured in monitoring wells in 2000. On Figure 2-10, circles are used to represent locations of wells that were sampled, and the sizes of the circles reflect the dissolved copper concentration. In the vicinity of the mine pits, concentrations of copper range from 50 to just over 300 mg/L. Dissolved copper concentrations are generally less than 10 mg/L in the Cropsy Valley, and even less in lower Cropsy Valley. Dissolved iron concentrations are also high in groundwater surrounding the mine pits and range from several 100s to nearly 1,300 mg/L. The pH of bedrock groundwater at the mine pits is generally in the range of 2.5 to 3.5. Cyanide contamination in groundwater occurs within the Heap Leach Pad, where total cyanide reaches 10 mg/L. The groundwater in the Heap Leach Pad is basic due to the lime added to the ore. Numeric water quality standards have not been established for groundwater at the site.

Limited data are available for site soils and sediments. Most of the data for these media were collected from the Land Application Areas between 1988 and 1991; from the Heap Leach Pad from 1992 through 1994; and from Cropsy Creek and Wightman Fork in 1994. Due to site reclamation activities over the past several years, most of the site soils have been altered by grading and by amendments of compost and lime. Concentrations of COCs in site soils are not representative of current conditions, and therefore not presented.

Waste generated at the site consists of sludge (filter cake) that is produced by the WTP. Samples of sludge have been recently collected and analyzed by Toxicity Characteristic Leaching Procedures (TCLP) to determine if the sludge is hazardous. Concentrations of leachable metals are consistently below regulatory standards for hazardous wastes, thus, the sludge material is not a Resource Conservation and Recovery Act (RCRA) hazardous waste and can be disposed of as a solid waste in a Subtitle D facility.

2.9.2 Areas 2 through 5 - Off-Site

With few exceptions, concentrations of COCs in downstream surface water are greatest in Area 2 (Wightman Fork), as shown in Table 2-2. This increased level of COCs in Area 2 is expected because it is the immediate receiving water for site contaminants. Maximum concentrations of metals in Wightman Fork are in the few mg/L range, in contrast to maximum concentrations of metals in on-site surface water that are in the 10s to 100s of mg/L. The acidity of water in Wightman Fork ranges from a pH of about 4.9 to 7.8. A source of alkalinity in Wightman Fork is a result of the WTP effluent that has a pH in the range of 8 to 9.

In the Alamosa River downstream of Wightman Fork (Area 3) most metals concentrations decrease several times as compared to Area 2. This decrease is mostly attributable to dilution from the Alamosa River above Wightman Fork. However, iron concentrations may increase in Area 3 due to the influx of iron from the Alamosa River basin upstream of Wightman Fork. The upstream areas are also a source of acidity. Consequently, the pH of the water in Area 3 maintains a similar range of values as in Wightman Fork, indicating that the Alamosa River upstream of Wightman Fork has depressed values of pH.

Concentrations of COCs continue to decrease in Area 4 (Terrace Reservoir). Most of the acidity in the water is lost by the time water enters Terrace Reservoir, demonstrated by the water having a range of pH from about 6.6 to 7.5.

In Area 5 (downstream of Terrace Reservoir), concentrations of COCs slightly decrease further except for manganese, which maintains concentrations similar to the water in Terrace Reservoir. Based on offsite surface water sampling performed in 1998, 1999, and 2000, COCs have exceeded aquatic life and/or agricultural water quality standards in the Alamosa River and Terrace Reservoir. The following summarizes exceedances of standards over this period of time:

- Copper exceeded the chronic or acute standard in most all sampling events from the confluence with Wightman Fork to the Town of Jasper.

- The State of Colorado agricultural manganese standard was almost always exceeded in both Terrace Reservoir and in the Alamosa River downstream of Terrace Reservoir.

- State of Colorado standards for zinc and cadmium were occasionally exceeded in the Alamosa River due to inflows from Wightman Fork.

- The State of Colorado standards for iron, aluminum, and pH were occasionally exceeded in the Alamosa River. These exceedances were due, at least in part, to sources in the Alamosa River upstream of Wightman Fork.

Although water quality standards continue to be exceeded in the Alamosa River and Terrace Reservoir, there has been a significant reduction in metals concentrations in Terrace Reservoir. Comparison of data collected in 1994 to data collected in 2000 shows that the median dissolved and total recoverable concentrations of aluminum, copper, iron, manganese, and zinc have been reduced by 48 to 99 percent. The greatest reduction has been for copper and the lowest reduction has been for manganese, as shown in the table below.

Metal	***Analysis***	***Metal Concentrations in Terrace Reservoir (ug/L)***		***Percent Reduction 1994 to 2000***
		1994 4 Events Median Values	***2000 4 Events Median Values***	
Aluminum	Dissolved	479	55	88%
	Total Recoverable	396	110	72%
Copper	Dissolved	845	5	99%
	Total Recoverable	759	10	99%
Iron	Dissolved	1,420	20	99%
	Total Recoverable	1,410	280	80%
Manganese	Dissolved	723	340	53%
	Total Recoverable	605	313	48%
Zinc	Dissolved	299	40	87%
	Total Recoverable	252	40	84%

Maximum and minimum concentrations of COCs for in- stream sediments and bar deposits in offsite areas are shown in Table 2-3. Concentrations are from the August 2000 comprehensive sampling effort. In general, most metals concentrations for both in-stream and bar deposits maintain similar ranges of concentrations for each offsite area (Areas 2 through 5). For a few metals, however, some differences are evident. A noticeable decrease in arsenic and lead concentrations is apparent from Area 2 (Wightman Fork) to Area 3 (Alamosa River). Copper concentrations also decrease from Area 2 to Area 3, but then increase in Area 4 (Terrace Reservoir). Concentrations of manganese slightly increase from Area 3 to Area 4. Numeric standards, either at the Federal or State level, do not exist that address stream sediments. Select in-stream and bar deposit sediment samples have been tested using TCLP methods. Results of these analyses showed that the sediments are not a RCRA hazardous waste.

2.9.3 Domestic Wells

The concentration of COCs in groundwater samples from domestic wells (Table 2-2) are below Maximum Contaminant Levels (MCLs), suggesting that well water quality has suffered no widespread effect from mine drainage. This conclusion is based on sampling of domestic wells in Areas 3 and 5. Infrequent detections of lead and copper above action levels have occurred. Concentrations of lead and copper may be elevated in private wells because of leaching of metals from pipes. A few wells have had elevated manganese (above secondary MCL of 50 ug/L). Some of the manganese detections, however, were from control samples from wells outside the influence of the Alamosa River, thus, manganese in well water may be elevated on a regional basis because of background concentration in soils. Cadmium has been detected above its MCL of 5 ug/L in isolated wells; however, retesting of water from these wells found cadmium to be below its MCL.

2.10 Location of Contamination and Known or Potential Routes of Migration

Contamination occurs at several areas of the site because of wide- spread mining disturbances and mineralized terrain that generates acidic drainage. The major locations of aqueous contamination generally coincide with the previously described source areas (Section 2-5).

The primary route of contaminant migration at the site is via surface water. Surface water is also the primary route by which site contaminants migrate offsite and to downstream areas. A network of diversion ditches has been constructed during reclamation (OU4) to intercept runoff and acid mine drainage. These diversion ditches are shown on Figure 2-3. Surface water collected in reclaimed areas is routed to Ditch R, which discharges into Cropsy Creek and ultimately into Wightman Fork. Ditches below the Highwall and mine pits route water to the SDI, if sufficient storage is available, otherwise the water is diverted to Ditch R and into Wightman Fork.

Although the network of ditches currently control most of the acid mine drainage at the site, some areas continue to discharge acid mine drainage to Wightman Fork. These areas include seepage from a wetlands area between the North Waste Dump and Wightman Fork and seepage through the embankment of the SDI. Another means by which contamination migrates offsite is through releases coming from the SDI outlet works. During the spring and early summer, when the storage capacity of the SDI and treatment rate of the WTP may be exceeded, it is necessary to make controlled releases of the contaminated water stored in the SDI through the outlet works. Otherwise, uncontrolled releases would occur through the SDI’s spillway. Monitoring of Wightman Fork in 1999 during times when these controlled releases occurred showed that the releases immediately impacted water quality in Wightman Fork, most notably by a drop in pH. The following table summarizes releases from the SDI since 1996.

Year	***Volume of Water Released from SDI***		***Estimated Mass of Copper Released (pounds)***	***Percent Snow Pack Compared to Normal***
	Gallons	***Acre-Feet***		
1996	0	0	0	28%
1997	169,000,000	518	35,000	208%
1998	9,800,000	30	1,500	107%
1999	53,000,000	164	5,600	131%
2000	0	0	0	67%
2001	11,700,000	36	1,400	108%

Note: Years when no releases were made were preceded by below normal winter snow pack.

A secondary route of contaminant migration is through groundwater. Acidic groundwater containing elevated metals originates in the mineralized ore zone in the vicinity of the mine pits, then migrates toward the north-northeast. At the lower elevations of the mine, the groundwater may daylight at the ground surface as seepage where upward gradients occur, or where contrasts in geologic material cause upward flow. After the groundwater reaches the ground surface most of it becomes part of the site’s surface water flow system and is captured by the ditch system shown on Figure 2-3.

To a much lesser extent, groundwater underflow migrates to and impacts Wightman Fork. This primarily occurs through the colluvium along the banks of Wightman Fork, but may also occur through bedrock fractures where Wightman Fork is in direct contact with bedrock. In both instances, the groundwater contamination becomes part of the surface water system and is transported offsite via Wightman Fork. Available data from monitoring wells at the downstream boundary of the site indicate that contaminants are not migrating offsite in groundwater underflow.

2.11 ***Aquifers Affected by Site Contamination***

2.11.1 Bedrock Aquifer

The bedrock aquifer is the primary groundwater affected by site contaminants. Bedrock at the site is comprised of several Tertiary Age rock types of volcanic origin, some of which have undergone varying degrees of hydrothermal alteration. Groundwater within the bedrock aquifer occurs within two rock types: quartz latite and andesite. Groundwater occurs in pore spaces and fractures in both rock types. Groundwater in the quartz latite is acidic and contains elevated metals, especially in the area of the mine pits where mineralized rock is most prevalent. Andesite outcrops in a sub-circular basin around the periphery of the site. Groundwater within the andesite is typically of good quality except where it is near or in contact with groundwater migrating from the quartz latite.

Structural features or discontinuities, including faults, fractures, and joint sets transect the site. These features can affect local groundwater flow direction and rate by either providing preferred flow pathways, or by acting as a barrier to flow due to the presence of lower permeability fault in-fill materials.

The bedrock aquifer is known to extend several hundred feet below the ground surface. Deepest wells are at the former mine pits and have penetrated quartz latite to a depth of over 480 feet. The bedrock at this depth is reported to still contain fractures and vugs. Plugging of the lowermost Reynolds Adit in 1994 inundated the underground workings and lower adits, creating a pool of water referred to as the “mine pool.” The mine pool generally lies beneath the former mine pits.

The groundwater table of the bedrock aquifer generally follows the topography of the land surface and is directed toward Wightman Fork. Groundwater flows primarily to the north-northeast. At areas where mining activities have taken place, such as at the mine pits and Heap Leach Pad, the water table is commonly over 100 feet below ground surface during the summer, and may be as much as 200 to 250 feet below ground surface during periods of low water levels in the winter and early spring.

Groundwater levels decrease in the fall and winter, and are lowest from February through April when the ground is frozen and precipitation is held in the snow pack with little recharge. Extensive snow melt and thawing of the ground in June leads to highest water levels typically from mid-June to early July.

The average groundwater velocity in the bedrock aquifer was estimated to be 0.9 feet/day or about 330 feet/year. The relatively high velocity is primarily due to high gradients that have been measured in the bedrock aquifer between the mine pits and low elevations of the site. The groundwater velocity in discrete fractures is expected to be greater.

2.11.2 Colluvium/Alluvium

Although not considered an aquifer, groundwater within the colluvium has been affected by site contaminants. Colluvium consists of predominantly gravel-to cobble-size material with interstitial clay, silt, and sand, and is of alluvial or glacial origin. It covers the slopes of the site and fills the drainages. Near the mine pits, the colluvium may be thin and is not saturated. Saturated colluvium is generally found below 11,500 feet at the site. The thickness of colluvium is up to 43 feet, but more commonly ranges from 10 to 15 feet thick. Alluvium is also found in the drainages and is comprised of medium to coarse grained sand with gravel. The alluvium, however, is limited in extent and is found as small lenses generally less than a few feet thick.

Groundwater in the colluvium is unconfined. The saturated thickness of colluvium material varies from as little as two feet to 15 feet. Groundwater flow is controlled by topography. Colluvial groundwater issues as seepage where permeability contrasts in geologic material occur. Metal contaminants in the colluvial groundwater discharge to Wightman Fork, where they enter the surface water flow system and are transported offsite.

Depths to groundwater in the colluvium vary from as little as one-half foot north of the North Waste Dump in a wetland area to 10 feet below ground surface in the vicinity of the WTP.

2.12 Current and Potential Future Land Uses and Resource Uses

2.12.1 Land Use

The land use in the vicinity of the site changes with distance from the site, and elevation.

2.12.1.1 On-Site

The site is located within the U. S. National Forest system lands that make it desirable for recreation such as snow skiing, hiking, camping, hunting, and livestock grazing. However, access to the site is currently restricted to authorized personnel only. Human activity, due to on-going Superfund activity, is considerable during the field season from May through October, and infrequent during the winter.

The primary economic resource of the site is its mineralized areas that contain gold, silver, copper, and other metals. Mining of these resources ceased in 1992. It is expected that the future land use of the site will not change in the near- term (i.e., several years through implementation of final remedy). The long- term use of the site is not known, but expected to be used as ecological habitat including wetlands. The land at the site is disturbed by past mining and current reclamation activities.

2.12.1.2 Offsite

Land downstream of the site to Terrace Reservoir is largely controlled by the U. S. Forest Service. The remaining land is privately owned. The area is largely in an undisturbed state and is characterized by diverse terrain and vegetation typical of the south-central Colorado Rocky Mountains. The area supports snowmobiling, cross country skiing, hiking, camping, horseback riding, hunting, livestock grazing, and other recreational activities. These land uses have occurred for decades and are not expected to change in the future.

There are no residences or schools within two miles of the site. The nearest year- round downstream residents are in the Town of Jasper on the Alamosa River, approximately seven miles downstream of the site. About 150 private property owners are in or around Jasper, however, there are only a few year-round residents due to limited accessibility in the winter months. Stunner Campground is on the Alamosa River, but it is upstream of Wightman Fork and therefore is unaffected by the mine. The Mountain Trails Youth Ranch is 12 miles downstream of the mite site. Phillips University Camp is approximately 13 miles downstream of the mine.

The land downstream of Terrace Reservoir opens to the San Luis Valley, which is largely privately owned and has been used for agricultural purposes for several decades. This land use is not expected to change. Crops include barley, potatoes, and alfalfa. The irrigated areas of the San Luis Valley receive both spray and ditch irrigation. Farms along the Alamosa River have meadows and pasture land upon which livestock graze. Small towns are among the irrigated land. The Towns of Capulin and Centro lie near the Alamosa River and supply retail services and support the rural agricultural community. Residents of the San Luis Valley living downstream of Terrace Reservoir within approximately 25 miles of the site, constitute the closest downstream population affected by the Summitville Mine.

2.12.2 Surface Water and Groundwater Uses

2.12.2.1 On-Site

Wightman Fork and Cropsy Creek are the major surface water drainages at the site. The water in these creeks is not used for human consumption or operational purposes. The current use of surface water at the site is expected to remain the same in the future.

Site groundwater is not used for human consumption. Groundwater is used to supply the site with non-potable water for site operations. The WTP requires relatively clean water for mixing of polymers and in the past several years, the WTP has used two bedrock wells north of Wightman Fork for a non-potable supply of water.

2.12.2.2 ***<u>Offsite</u>***

The primary use of surface water is for irrigation of croplands in the San Luis Valley. This area depends upon water from the mountains to support agricultural practices. Approximately 45,000 acres of the San Luis Valley is irrigated with water from Terrace Reservoir. Terrace Reservoir is operated by the Terrace Reservoir Irrigation Company, which regulates the use of the reservoir for storage and release of water for irrigation. Water from the Alamosa River is also used by farmers for watering of livestock that includes cattle, hogs, horses, and sheep. Downstream of Terrace Reservoir water is further diverted for consumptive irrigation use and thus, the Alamosa River never reaches the Rio Grande River because its waters are totally appropriated. The secondary use of surface water is for fishing and recreation. As a result of the discharges from the Summitville Mine, fish kills occurred in 1990 and 1991, and fishing and recreational uses ceased. The Alamosa River could be used for fishing and other recreational uses in the future if water quality were restored.

Groundwater downstream of the site is used for drinking water. The nearest domestic well is approximately seven miles downstream in the Town of Jasper. Approximately 30 private wells have been identified in the Jasper area. These wells are located outside of the Alamosa River floodplain, and not within the alluvial sediments that have been impacted by site and naturally occurring contaminants. One well is located at Mountain Trails Youth Ranch. Wells are located at the Alamosa Campground and Phillips University Camp, but these wells are not in use due to high particulate or coliform contamination. Several domestic use wells are located just downstream of Terrace Reservoir. Approximately 100 wells are permitted to San Luis Valley residents for domestic use. Two municipal wells are used in Capulin. The wells receive groundwater from shallow aquifers in the alluvium of the Alamosa River or shallow unconfined aquifer in the valley. Private wells may be located near irrigation ditches or irrigated fields that received Alamosa River water. Future use of groundwater in these areas is expected to remain the same.

3.0 ***SUMMARY OF RISKS***

This section of the Record of Decision summarizes the results of the human health risk assessment and ecologic risk assessment for the Summitville Mine site and downstream areas. The response action selected in this Record of Decision is necessary to protect the public health or welfare, or environment from actual or threatened releases of hazardous substances into the environment.

3.1 ***Human Health Risks***

Human health risks were estimated in the Baseline Human Health Risk Assessment (Morrison Knudsen Corporation and ICF Kaiser Engineers, 1995a). The 1995 baseline risk assessment estimated the risks posed by contaminants migrating from the site to various media, and identified the contaminants and exposure pathways that needed to be addressed by remedial action. This risk assessment was conducted prior to the implementation of the interim remedial actions.

Human health risks were assessed for exposure Areas 1 through 5, which are shown on conceptual site model (Figure 2-2). Risks were assessed using two methods, either qualitative or quantitative, depending on the exposure medium, receptors, and toxicological information. Qualitative risk assessment methods were used when data were of insufficient quantity or quality to estimate chemical doses. Qualitative risk assessment is a process of comparing limited data to relevant risk-based benchmarks (e.g., MCLs or health advisories). The chemical doses or intakes are compared to health effects criteria. Risks were qualitatively assessed in Areas 1 through 5. Quantitative evaluations were used when sufficient data were available to calculate chemical doses to receptors based on chemical concentrations in the exposure media. For potential carcinogens, quantitative excess lifetime cancer risks were calculated. Non-carcinogenic risks were assessed by calculating the Hazard Index (HI). Risks were quantitatively assessed in only Area 3.

Selection of chemicals of concern was based on a comparison of data acquired prior to the open- pit mining that began in June 1986 to data acquired after open-pit mining began. A date for pre-impact (background) to post-impact of July 1987 was estimated based upon an observed increase in metals concentrations at that time.

The chemicals determined to be significantly greater than background, as well as those without sufficient data to statistically compare, were screened for their potential toxicity to humans. This screening eliminated those chemicals that were relatively non-toxic or at relatively low concentrations, and retained only those COCs that have a reasonable potential for contribution to risk. This screening employed a comparison of chemical concentrations to Recommend Daily Allowances, calculated acceptable concentrations in drinking water, human health advisories, maximum contaminant levels, Colorado State Agricultural standards, and preliminary remediation goals (U.S. EPA, 1994). To be conservative, the lowest of these values was used to determine the chemical   s level of concern.

Chemicals of concern, potentially exposed populations, routes of exposure, and assessment of human health risks are presented for each exposure area follows.

3.1.1 Area 1 - On-Site

On- site human health risks were qualitatively assessed. The likely on- site receptor is an adult trespasser. Workers were assumed to be protected under Occupational Safety Health Administration regulations for hazardous waste sites. No sensitive subpopulations, (i.e., children), were identified. The exposure media included air, sediment, and surface water. Exposure to groundwater was not considered to pose a risk to a trespasser because of the limited exposure route. Exposures to site contaminants were expected to occur acutely. Exposure routes include inhalation, ingestion and dermal contact with surface water, and ingestion of sediment. The following table presents a summary of the qualitative risk assessment.

Area 1 - On-Site Summary of Qualitative Risks					
Receptor	***Exposure Media***	***Exposure Route***	***Contaminant***	***Toxic Effect***	***Likelihood of Effect***
Adult Trespasser	Air	Acute Inhalation	hydrogen cyanide	acute lethality	very low
	Surface Water	Acute Ingestion	aluminum	fluid retention	moderate
			antimony	g.i. irritation	very low
			arsenic	acute lethality	very low
				g.i. irritation	moderate
			copper	g.i. irritation	high
			cyanide (WAD)	acute lethality	very low
				g.i. disturbance	moderate
			iron	g.i. irritation	moderate
			manganese	g.i. irritation	moderate
	Surface Water	Acute Dermal	pH	skin irritation	moderate
	Sediment	Acute Ingestion	arsenic	acute lethality	very low
			manganese	g.i. irritation	low

Note: g.i. refers to gastrointestinal

Gastrointestinal effects from surface water ingestion are the most relevant toxic response that would be expected from the exposure scenarios. The effects of ingesting significant amounts of surface water would probably be severe, with copper being the greatest contributor to the effect. However, due to taste avoidance, it is highly unlikely that a trespasser would drink a sufficient amount of water to have a toxic effect.

3.1.2 Area 2 - Wightman Fork

Human health risks were qualitatively assessed for this area. The likely receptor would be a recreational user because access to Wightman Fork is limited. No residents live in this area and no sensitive subpopulations were identified. The exposure media include surface water and sediment. Groundwater is not a media of concern because no wells are in this area. Exposure is expected to occur acutely because the area has limited access. Exposure routes include ingestion and dermal contact with surface water and ingestion of sediment. The following table presents a summary of the qualitative risk assessment.

Area 2 - Wightman Summary of Qualitative Risks					
Receptor	***Exposure Media***	***Exposure Route***	***Contaminant***	***Toxic Effect***	***Likelihood of Effect***
Recreational User	Surface Water	Acute Ingestion	aluminum	fluid retention	low
			antimony	g.i. irritation	moderate
			arsenic	acute lethality	very low
				g.i. irritation	moderate
			copper	g.i. irritation	high
			cyanide (WAD)	acute lethality	very low
				g.i. disturbance	low
			iron	g.i. irritation	moderate
			manganese	g.i. irritation	moderate
	Surface Water	Acute Dermal	pH	skin irritation	moderate
	Sediment	Acute Ingestion	aluminum	fluid retention	very low
			arsenic	g.i. irritation	low to moderate
			copper	g.i. irritation	very low
			iron	g.i. irritation	very low
			manganese	g.i. irritation	Very low to low

Note: g.i. refers to gastrointestinal

The relative likelihood of an effect from exposure to surface water and sediment in Area 2 is anticipated to be similar to or less than Area 1 because of dilution of chemicals that occurs downstream of the site. Gastrointestinal effects from surface water ingestion of copper are the most relevant toxic response that would be expected from the exposure scenarios. Due to taste avoidance, it is highly unlikely that a human would drink a sufficient amount of water to have an effect. Ingestion of sediments containing arsenic might pose a moderate toxic response, but similar to ingestion of surface water, it is highly unlikely that a human would ingest the quantity of sediment to induce an effect.

3.1.3 Area 3 - Alamosa River Below Wightman Fork to Terrace Reservoir

Human health risks were assessed both quantitatively and qualitatively in this area. Receptors include adult and juvenile residents and recreational users. No sensitive subpopulations were identified. Exposure media include surface water, sediment, and groundwater. Exposure pathways include ingestion and dermal contact with surface water, ingestion of sediment, and ingestion of groundwater.

For pathways that were quantitatively evaluated, exposure point concentrations of COCs were estimated to calculate the magnitude of exposures and risk. The exposure point concentrations were estimated with assumptions on the rate and magnitude of chemical contact. Because of the uncertainty associated with any estimate of exposure concentration, the 95 percent upper confidence limit on the arithmetic mean concentration was used as the exposure point concentration. Exposure concentrations were estimated for three points (Alamosa River sampling stations) in Area 3:

- AR45.4 (downstream of Wightman Fork Confluence),
- AR44.4 (near Jasper), and
- AR34.5 (Phillips University Camp)

The following table summarizes the exposure point concentrations for juveniles and adults.

Chemicals Exhibiting Carcinogenic Effects	***Area 3 - Reasonable Maximum Exposure (RME) Exposure Point Concentration (ug/L) for Ingestion of Surface Water by Resident/Recreational User***		
	AR45.4	***AR44.4***	***AR34.5***
Arsenic	36.3	7.5	16.5
Beryllium	Not Applicable	Not Applicable	1.2
Chemicals Exhibiting Noncarcinogenic Effects			
Aluminum	4,760	3,280	6,710
Arsenic	36.3	7.5	16.5
Beryllium	Not Applicable	Not Applicable	1.2
Cadmium	4.0	2.6	2.3
Copper	3,980	1,220	1,390
Cyanide	30.4	624	29.4
Manganese	1,050	585	805
Nickel	28.6	23.0	18.3
Zinc	487	274	360

Quantification of exposure was estimated by combining concentrations at the select exposure points with information describing the extent, frequency, and duration of exposure for each receptor of concern. The approaches used to quantify exposures were consistent with U. S. EPA guidance (1989, 1991b, and 1992) at the time the risk assessment was prepared.

For carcinogens, risk is generally expressed as the incremental probability, of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. An excess lifetime cancer risk of 1 x 10-6 suggests that an individual experiencing the reasonable maximum exposure has a 1 in 1,000,000 chance of developing cancer as a result of being exposed to the carcinogen. The generally acceptable risk range for site-related exposures established by U. S EPA is 10-4 to 10-6.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period with a reference dose derived for a similar exposure period. A reference dose represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called the hazard quotient (HQ). A HQ less than 1.0 indicates that a receptor’s dose of a single contaminant is less than the reference dose, and that toxic non- carcinogenic effects from that chemical are unlikely. The hazard index, HI, is generated by adding the HQs for all chemicals of concern. A HI less than 1.0 indicates that, based on the sum of HQs, toxic non-carcinogenic effects from all contaminants are unlikely. A HI greater than 1.0 indicates that site-related exposures may present a risk to human health. Carcinogenic and non-carcinogenic risks for surface water are summarized in the table below.

Area 3 - Alamosa River from Wightman Fork to Terrace Reservoir Summary of Quantitative Risks			
Carcinogenic Effects to Residents and Recreational Users			
Contaminant	***Exposure Media***	***Exposure Route***	***Range of Cancer Risk***
Arsenic	Surface Water	Ingestion	2 x 10-6 to 9 x10-8
Arsenic	Surface Water	Dermal contact	2 x 10-6 to 3 x 10-9
Non-Carcinogenic Effects to Residents and Recreational Users			
Contaminants	Exposure Media	Exposure Route	Hazard Index
COC metals	Surface Water	Ingestion	0.1 to 0.004
COC metals	Surface Water	Dermal Contact	0.1 to 0.004

Cancer risk posed by arsenic through these exposure routes was within acceptable levels for all of Area 3. Non-carcinogenic risks were assessed by adding HQs for individual metals that included aluminum, arsenic, beryllium, cadmium, copper, cyanide, manganese, nickel, and zinc to calculate the overall HI. The cumulative hazard posed by all metals analyzed in surface water does not appear to be significant. Hazard Index values for ingestion of surface water were less than 1.0. Hazard Index values for dermal contact with surface water were also all less than 1.0.

Ingestion of sediment was evaluated qualitatively against health-based benchmarks. None were exceeded for any metal. Therefore, an individual exposed to surface water and sediments is not expected to experience adverse effects from the cumulative exposure of the three pathways.

Groundwater from Area 3 was evaluated, but little is known about the effect surface water contamination may have on groundwater. Metal concentrations from wells are generally below analytical detection limits. Copper and zinc have had low detectable concentrations, but the source of the metal could be from piping in the water supply system. The low detections were below Federal MCLs. Therefore, while the groundwater flow path is not fully characterized in Area 3, there is not a significant risk or hazard.

3.1.4 Area 4 - Terrace Reservoir

Potential risk in Area 4 was not estimated. The potential for human exposure in Terrace Reservoir is limited.
Near shore sediment and water concentrations would be the media of most concern, but in this instance, it is
not a concern because much of the reservoir is virtually inaccessible to potential receptors. There are no
residents at the reservoir, although occasional recreational use is possible. Exposures and risks are likely to
be less than those described in Area 3.

3.1.5 Area 5 - Downstream of Terrace Reservoir and in the San Luis Valley

Potential risks for Area 5 were assessed qualitatively by comparison to risks calculated for Area 3. Receptors of concern are residents who live along the Alamosa River and use groundwater recharged by the river, or use river water to irrigate crops and to water livestock. Incidental ingestion and dermal contact with surface water, and ingestion of sediment are the routes of exposure. Using these risk assumptions did not significantly alter the potential risk over that found in Area 3. Because chemical concentrations in Area 5 are less than in Area 3, the use of Area 3 for surface water exposure in Area 5 is conservative. Copper is the only chemical present that may pose a short-term risk for sensitive subpopulations, primarily children.

Cancer risks and HI values for dermal contact with surface water are minimal. Risks from ingestion of sediments in Area 5 are expected to be similar to Area 3, which were found to be not significant.

Risks due to consumption of groundwater within the San Luis Valley were not performed in the Baseline Human Health Risk Assessment because sufficient data were not available. However, recent sampling of domestic wells in 1998 and 1999 showed that there were generally no concerns for the parameters that were tested as far as the use of the water for drinking water purposes.

3.1.6 Major Assumptions and Uncertainty

This section addresses the major assumptions and uncertainty associated with the human health risk assessment. The method in which exposure point concentrations were calculated in the risk assessment was generally conservative. The upper 95 percent confidence limit of the population mean or maximum was used to calculate exposure point concentrations. This confidence limit tends to overestimate risks. However, in some areas exposure point concentrations were based on limited data, which could either over- or under-estimate risks.

Default U. S. EPA assumptions regarding body weight, duration of exposure, and life expectancy were used and may not be representative for the site and downstream area populations. An example of this was the assumption that receptors will contact surface water on a regular, daily basis. These assumptions are viewed as being conservative and may overestimate risk.

The risk assessment was based on data available through 1994. Considerable data have been collected since that time at both on-and offsite areas and shows the risks posed by the site today are believed to be lower than estimated in 1995. Lower risks are based on the considerable reclamation and contaminant reduction that has occurred at the mine since the time the risk assessment was conducted. These activities have reduced on-site exposure to contaminants, as well as releases of contaminants to downstream areas. The significant reduction in contaminant concentrations in Terrace Reservoir since 1994 (between 48 to 99 percent reduction in median metals concentrations in surface water, Section 2.5.9) demonstrates the success of response actions and interim remedial actions at the site. It is therefore reasonable to expect that the current human health risks in the Alamosa River system are less than those calculated in the Baseline Human Health Risk Assessment.

This expectation has been supported by a Public Health Assessment of the site and downstream areas performed in 1997 by U. S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR, 1997). The Public Health Assessment classified the site as posing no apparent public health hazard, but the assessment did support continued studies of aquatic and terrestrial media.

3.2 Ecological Risks

Ecological risk assessments have been conducted for the site and downstream areas. An initial Tier 1 Ecological Risk Assessment was conducted from the 1993 to 1994 (Morrison Knudsen Corporation, ICF Kaiser Engineers, Inc., 1995b). The Tier 1 assessment concluded that contaminant releases from the site presented a risk to ecological receptors downstream. However, significant uncertainties or gaps in the data were identified. A Tier 2 Ecological Risk Assessment was later conducted that included data from additional studies performed between 1995 and 1997 (CDM Federal Programs, 2000). Results of the Tier 2 assessment are summarized below.

Like the human health risk assessment, the Tier 2 Ecological Risk Assessment was performed for the site and downstream study areas. However, a new area (Area 3a) was added and the former Area 3 (Alamosa River) was subdivided into two segments, Areas 3b and 3c (Figure 2-1). New Area 3a included the Alamosa River upstream of the confluence with Wightman Fork. Area 3a is not impacted by the site, but instead it is influenced by naturally occurring mineralized terrains and minor acid mine drainage present in this area. Alum, Bitter, and Iron Creeks are tributary to the Alamosa River in Area 3a. Area 3b included the Alamosa River from Wightman Fork to Fern Creek near the Town of Jasper. Area 3c included the Alamosa River from Fern Creek to Terrace Reservoir. No additional samples were collected from Area 4 (Terrace Reservoir); thus, risks were not re-evaluated for Area 4.

Two types of ecological receptors were evaluated in the risk assessment, aquatic and terrestrial. Aquatic receptors included rainbow trout and macroinvertebrates. Studies show that rainbow trout are more sensitive to metals than other species of trout, and toxicological values based on rainbow trout would be protective of most all aquatic receptors. Aquatic macroinvertebrates were used as a receptor because of their close contact with sediment and their importance as prey base for fish.

Terrestrial receptors included elk, domestic and range sheep, and the meadow vole in Areas 1 and 2. In addition to these, receptors in Area 3 included beaver, mallard ducks, and spotted sandpiper. The Canadian goose was additionally evaluated in Area 5. Results of the Tier 1 Ecological Risk Assessment found that these terrestrial receptors were at negligible excess risk from exposure to COCs in surface water compared to aquatic receptors. However, gaps in toxicity data did not allow for complete evaluation of risks to mallard ducklings. Although not strictly ecological components, the risk assessment evaluated pastureland, crops, and soil irrigated with Alamosa River water and livestock (sheep) for Area 5.

In the Tier 2 Ecological Risk Assessment, chemicals of concern (i.e., risk drivers) were selected based on concentrations from surface water samples collected for years 1995 through 1997, comparison of chemical concentrations to essential nutrient concentration, and comparison of chemical concentration to ecological water quality standards and criteria. The risk drivers included copper, cyanide, iron, zinc, and pH. Cyanide was not detected in surface water samples collected throughout the watershed in 1995. Although retained as a risk driver, cyanide was not evaluated quantitatively due to lack of detection.

Potential exposure pathways to aquatic receptors were based on the assumption that aquatic receptors are exposed to site chemicals in surface water and sediment. Potential pathways include:

- Direct contact with surface water,
- Ingestion of surface water,
- Direct contact with sediments,
- Ingestion of sediment, and
- Ingestion of food items.

Potential exposure pathways for terrestrial receptors include:

- Direct contact with surface water (mallard ducklings only),
- Ingestion of surface water (mallard ducklings only),
- Direct contact with sediment (mallard ducklings only),
- Direct contact with soil (plants only),
- Uptake of chemicals in soil (plants only),
- Ingestion of soil (sheep only), and
- Ingestion of vegetation (sheep only).

Risks to ecological receptors were evaluated by comparing the risk driver concentrations in surface water to toxicological reference values, which is termed the Hazard Quotient (HQ). A HQ greater than 1.0 is interpreted as a level at which adverse ecological effect may occur, although there is no indication of the magnitude of the effects. The following presents a summary of ecological risk for each of the defined areas, as presented in the Tier 2 Ecological Risk Assessment (CDM Federal Programs, 2000).

3.2.1 Area 1 - On-Site

Acute and chronic HQ for both aquatic receptors (rainbow trout and macroinvertebrates) greatly exceed 1.0 for each year (1995 through 1997), which included early snowmelt, snowmelt, summer, and baseflow. Risks were driven primarily by copper and low pH. Extremely high risks in this area preclude survival of aquatic life. Terrestrial receptors were at negligible risk. The Colorado Water Quality Control Commission has not given an aquatic life classification to Wightman Fork. Area 1 is not expected to support aquatic life.

3.2.2 Area 2 - Wightman Fork

Acute and chronic HQs for both aquatic receptors exceeded 1.0 for each flow regime during 1995 through 1997. Copper was responsible for the majority of acute and chronic risks. Extremely high risks in this area preclude survival of aquatic life. Terrestrial receptors were at negligible risks. The Colorado Water Quality Control Commission has not given an aquatic life classification to Wightman Fork in this area. Wightman Fork is not expected to support aquatic life:

3.2.3 Area 3a - Alamosa River Upstream of Wightman Fork

This area is not impacted by contaminant release from the site. However, hydrothermally altered terrains drain to this segment of the river resulting in naturally occurring levels of metals and acidity. Minor amounts of loading from a few small abandoned mines also occurs in this area. Acute and chronic HQs for macroinvertebrates and acute HQs for rainbow trout exceeded 1.0 during 1995 through 1997. Hazard Quotients were sufficiently high during one or more of the flow regimes during each year to prevent the maintenance of fishery and macroinvertebrate communities. The greatest risks were posed by iron and low pH. Terrestrial receptors were at negligible risk. The Colorado Water Quality Control Commission has given this segment of the Alamosa River an Aquatic Life Cold 2 Classification. This classification is based on data indicating that this segment is not capable of sustaining a wide variety of cold water biota due to uncorrectable water quality conditions.

A more recent indication of the water quality in Area 3a is presented in the table below, which summarizes concentrations of the primary risk drivers (iron and pH) for 1999 and 2000 in Segment 3a of the Alamosa River. Exceedances of chronic water quality standards are noted.

Comparison of Measured Iron Concentrations and pH Values to Chronic Water Quality Standards in Alamosa River - Segment 3a (Measured at Station AR45.5)						
YEAR 1999						
Sample Date	April 14	May 19	May 26	June 22	Sept 19	Oct 19
Iron Concentration (ug/L)	8,040	<u>**14,000**</u>	2,290	1,670	6,200	10,000
Iron Standard (ug/L)	12,000	12,000	12,000	12,000	12,000	12,000
pH (Seasonal 3.52 to 4.72 - 9)	5.05	5.1	5.43	6.49	4.85	5.05
YEAR 2000						
Sample Date	April 19	May 16	Aug 22	Oct 10		
Iron Concentration (ug/L)	9,020	2,140	3,810	5,200		
Iron Standard (ug/L)	12,000	12,000	12,000	12,000		
pH (Seasonal 3.52 to 4.72 - 9)	4.62	6.48	4.36	5.64		

Notes: Iron standard is from Colorado Water Quality Control Commission Regulation No. 31, The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31), amended March 2, 1999.
<u>**Underlined Bolded**</u> values exceed the iron standard or pH values are outside of range.

3.2.4 Area 3b - Alamosa River from Wightman Fork to Fern Creek

Acute and chronic HQs for both aquatic receptors exceeded 1.0 from 1995 through 1997. These risks would prohibit the presence of naturally reproducing or a put, grow, and take fishery. Risks were generally driven by copper exposure. Terrestrial receptors, including mallard ducklings, were at negligible risk. The Colorado Water Quality Control Commission has given this segment of the Alamosa River an Aquatic Life Cold 1 Classification, indicating that the water could sustain a wide variety of cold water biota, but for correctable water quality conditions. However, the 1998 Use Attainability Analysis showed that an Aquatic Life Cold 2 is the most appropriate designation given the water quality in Segment 3a.

A more recent indication of water in Area 3b is provided in the table below for Segment 3b of the Alamosa River. The table summarizes concentrations of copper and pH for the years 1999 and 2000, noting instances when the chronic water quality standard has been exceeded.

Comparison of Measured Copper Concentrations and pH Values to Chronic Water Quality Standards in Alamosa River - Segment 3b (Measured at Station AR43.6)							
YEAR 1999							
Sample Date	April 14	May 21	May 26	June 11	June 22	Sept 19	Oct 19
Copper Concentration (ug/L)	**70**	10	**60**	**33**	10	**40**	**170**
Copper Standard (ug/L)	30	30	30	30	30	30	30
pH (6.5 - 9)	**5.38**	**5.92**	**5.45**	6.61	**5.99**	**5.91**	**5.01**
YEAR 2000							
Sample Date	April 19	May 17	Aug 23	Oct 10			
Copper Concentration (ug/L)	27	12	**208**	**173**			
Copper Standard (ug/L)	30	30	30	30			
pH (6.5 - 9)	**5.8**	6.93	**5.1**	**5.81**			

Notes: Copper standard is from Colorado Water Quality Control Commission Regulation No. 31, The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31), amended March 2, 1999.
Underlined Bolded values exceed the copper standard or pH values are outside of range.
The SDI was releasing contaminated water when the May 26, 1999 sample was collected.

3.2.5 Area 3c - Alamosa River from Fern Creek to Terrace Reservoir

Acute and chronic HQs for rainbow trout and macroinvertebrates exceeded 1.0 during 1995 through 1997. For rainbow trout, copper is the primary risk driver. Risks associated with iron generally exceed 1.0. Chronic risks to rainbow trout from exposure to low pH water exceed 1.0 for some flow regimes. Copper is also the risk driver for macroinvertebrates; however, risks from the remaining COCs (iron, zinc, and pH) were sufficient during one or more flow regimes to prevent establishment of macroinvertebrate communities. Terrestrial receptors were at negligible risk. This was also the case for mallard ducklings. The Colorado Water Quality Control Commission has given this segment of the Alamosa River an Aquatic Life Cold 1 Classification, indicating that the water could sustain a wide variety of cold water biota, but for correctable water quality conditions.

Concentrations of the primary risk drivers (copper and pH) from 1999 and 2000 are provided in the table below for Area 3c (Alamosa River Segment 3c). Exceedances of chronic water quality standards are noted.

Comparison of Measured Copper Concentrations and pH Values to Chronic Water Quality Standards in Alamosa River - Segment 3c (Measured at Station AR41.2)							
YEAR 1999							
Sample Date	April 14	May 21	May 26	June 11	June 22	Sept 19	Oct 19
Copper Concentration (ug/L)	**60**	<10	**40**	**96**	**7**	**30**	**100**
Copper Standard (ug/L)	14	6	8	5	5	14	22
pH (6.5 - 9)	**5.22**	6.5	**5.45**	6.73	6.94	**5.75**	**5.05**
YEAR 2000							
Sample Date	April 19	May 16	Aug 22	Oct 10			
Copper Concentration (ug/L)	**24**	**11**	**151**	**147**			
Copper Standard (ug/L)	12	8	21	21			
pH (6.5 - 9)	**6.41**	**6.34**	**4.88**	**5.63**			

Notes: Copper standard is from Colorado Water Quality Control Commission Regulation No. 31, The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31), amended March 2, 1999.
Underlined Bolded values exceed the copper standard or pH values are outside of range.
The SDI was releasing contaminated water when the May 26, 1999 sample was collected.
< = Analyte not detected above indicated detection limit.

3.2.6 Area 4 - Terrace Reservoir

The Colorado Water Quality Control Commission has given Terrace Reservoir an Aquatic Life Cold 2 Classification. This classification is based on data indicating that the reservoir is not capable of sustaining a wide variety of cold water biota due to physical limitations. Physical limitations result from annual drawdown of the reservoir. for irrigation and water rights to irrigators that prevent full aquatic life protection. Terrace Reservoir Irrigation Company allows the Division of Wildlife a minimum pool to place and ensure survival of stocked fish.

Risks for Area 4 were not recomputed in the Tier 2 assessment because no new data had been collected. The following findings were based on the Tier 1 Ecological Risk Assessment. Hazard quotients for rainbow trout were greater than 1.0 for copper, iron, zinc, and cadmium. Hazard quotients for macroinvertebrates exceeded 1.0 for copper and iron. Terrestrial receptors were at low risk.

A more recent indication of the water quality in Terrace Reservoir (Alamosa River Segment 8) is presented in the following table. The table summarizes copper concentrations and pH values for 1999 and 2000, noting instances when the chronic water quality standards have been exceeded.

Comparison of Measured Copper Concentrations and pH Values to Chronic Water Quality Standards in Terrace Reservoir - Segment 8 (Terrace Reservoir Measured at Station TIA)				
YEAR 1999				
Sample Date	April 15	June 24	Sept 20	Oct 20
Copper Concentration (ug/L)	**20**	**10**	<10	<10
Copper Standard (ug/L)	16	6	10	13
pH (6.5 - 9)	6.79	6.97	6.53	**6.39**
YEAR 2000				
Sample Date	April 20	May 18	Aug 24	Oct 11
Copper Concentration (ug/L)	5	**18**	4	3
Copper Standard (ug/L)	16	10	14	16
pH (6.5 - 9)	7.22	7.45	6.98	6.71

Notes: Copper standard is from Colorado Water Quality Control Commission Regulation No. 31, The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31), amended March 2, 1999.
Underlined Bolded values exceed the copper standard or pH values are outside of range.
< = Analyte not detected above indicated detection limit.

An acute (96-hour) toxicity caged fish study was performed in Terrace Reservoir during the fall of 2000. Metals- sensitive rainbow trout were placed in cages in three separate locations in Terrace Reservoir and left for 96 hours (four days). All fish survived. Dissections of several fish from each location indicated that the fish had fed off natural populations of zooplankton and macro-invertebrates during the test.

3.2.7 Area 5 - Alamosa River Downstream of Terrace Reservoir, San Luis Valley

Acute and chronic HQs for aquatic receptors exceed 1.0 for one or more flow regimes each year. These risks, however, were lower than the risks at upstream Area 3c. Risks to both rainbow trout and macroinvertebrates were generally driven by copper. Terrestrial receptors were at negligible risk. Risk was also negligible for mallard ducklings.

Potential risks to crops were evaluated using additional information obtained from several data gap studies. The chemical concentrations observed in vegetation were within livestock dietary guidelines and were far below livestock maximum tolerable levels. Chemical concentrations in vegetation were also within the ranges normally observed in vegetation in the United States. Furthermore, information from the studies suggests that lambs and adult sheep were not at risk of acute or chronic copper toxicity from ingestion of soil, vegetation, or surface water impacted by the Alamosa River. The Colorado Water Quality Control Commission has given the Alamosa River from the outlet of Terrace Reservoir to Colorado Highway 15 an Aquatic Life Cold 1 Classification. From Colorado Highway 15 to the point of final diversion the Alamosa River has an Aquatic Life Cold 2 Classification, because the river is not capable of sustaining a wide variety of cold water biota due to physical limitations.

Recent concentrations of copper, the primary risk driver, and values of pH for 1999 and 2000 are compared to chronic water quality standards in the table below for Area 5 (Alamosa River Segment 9). Instances when the standards have been exceeded are noted.

Comparison of Measured Copper Concentrations and pH Values to Chronic Water Quality Standards in Alamosa River - Segment 9 (Measured at Station AR31.0)						
YEAR 1999						
Sample Date	April 15	May 19	May 26	June 22	Sept 19	Oct 19
Copper Concentration (ug/L)	<10	<10	<10	<u>8</u>	<10	<10
Copper Standard (ug/L)	16	11	8	6	13	14
pH (6.5 - 9)	6.73	<u>**5.72**</u>	<u>**6.19**</u>	<u>**6.09**</u>	6.89	7.01
YEAR 2000						
Sample Date	April 20	May 18	Aug 24	Oct 11		
Copper Concentration (ug/L)	4	7	2	3		
Copper Standard (ug/L)	16	11	15	17		
pH (6.5 - 9)	7.0	7.15	6.7	6.96		

Notes: Copper standard is from Colorado Water Quality Control Commission Regulation No. 31, The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31), amended March 2, 1999.
<u>**Underlined Bolded**</u> values exceed the copper standard or pH values are outside of range.
The SDI was releasing contaminated water when the May 26, 1999 sample was collected.
< = Analyte not detected above indicated detection limit.

4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Remedial action alternatives at Superfund sites are analyzed to see if they meet all regulations, standards, criteria, etc. that are found to be applicable or relevant and appropriate. The National Oil and Hazardous Substance Pollution Contingency Plan (NCP, See 40 CFR § 300.5) defines “applicable” requirements as cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action location, or other circumstance found at a CERCLA site. “Relevant and appropriate” requirements address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the environmental or technical factors at a particular site. ARARs for remedial alternatives are divided into three principal categories.

- Chemical-Specific ARARs - Chemical-specific ARARs are based on human health or risk based specific chemical concentration limits or discharge limits in environmental media like air, water, or soil. Examples include, surface water quality standards, groundwater quality standards, and waste water discharge standards.

- Action-Specific ARARs - Action-specific ARARs are usually requirements or limitations placed on the operation of a facility. Examples include, operation of water storage reservoirs and work place safety.

- Location-Specific ARAR - Location-specific ARARs are restrictions placed on types of activities that may be performed in particular locations. Examples include, landfill siting requirements, wetlands, and floodplain management restrictions.

The NCP also identifies a fourth category of standards, limitations or restrictions that may have a bearing on a CERCLA site cleanup. This category, while not legally required, provides information that is “To Be Considered” when determining the appropriate response action for a CERCLA site. Included in this To Be Considered category are Federal, State and local government advisories, criteria, or guidance. While, To Be Considered information is discretionary and does not carry the force of a law or regulation, it may be useful in determining what remedial alternatives are protective of human health and the environment at a given site or may provide information regarding how to carry out certain actions or meet certain other requirements.

An analysis of ARARs for remedial alternatives is contained in Appendix E of the Feasibility Study (Rocky Mountain Consultants, Inc., 2001d). Those ARARs that were found to be “applicable” or “relevant and appropriate” and To Be Considered for the various remedial alternatives evaluated for the final remedial action at the site are summarized in Tables 4-1, 4-2 and 4-3.

In general, remedial alternatives that do not meet ARARs are not selected for the final clean up of a site. However, in some circumstances, an ARAR may be waived if such a waiver is determined to meet the criteria specified in CERCLA Section 121(d)(4) and if the lead agency can demonstrate that the remedial alternative is still protective of human health and the environment. Compliance of the Selected Remedy with ARARs is discussed in Section 6.5.2. Waiver of ARARs for the Selected Remedy is discussed in Section 8.2.1.

5.0 ***REMEDIAL ACTION OBJECTIVES***

Remedial Action Objectives (RAOs) are remedial goals of the site- wide remedy that address migration, exposure pathways, and potential receptors of contamination from the site. The goals provide the basic guide for evaluation of remedial alternatives, which will be presented in the next section.

The RAOs for the final remedy of the site (OU5) are presented below.

l. Control and treat surface water, groundwater and leachate, as necessary, to meet State and Federal ARARs.
2. Re-establish State aquatic use classifications and attainment of water quality numeric criteria in Segment 3c for the Alamosa River and downstream.
3. Ensure geotechnical stability of constructed earthen structures and slopes.
4. Mitigate erosion and transport of sediment into Wightman Fork and Cropsy Creek.
5. Control airborne contaminants from the site.

The Human Health risk assessments for the site and downstream study areas found there to be no adverse health risk to humans. However, sufficient acute and chronic risks occur to severely limit aquatic life (rainbow trout and macroinvertebrates) in the Alamosa River downstream of Wightman Fork. To achieve restoration of the Alamosa River, releases of site contaminants to Wightman Fork and downstream areas must be controlled. Active water treatment, in addition to eliminating releases of contaminated water from the on-site impoundment will significantly reduce the major aquatic risk driver (copper) to the Alamosa River system downstream of Wightman Fork, because the source of the copper is primarily from the site.

6.0 DESCRIPTION AND ASSESSMENT OF REMEDIAL ALTERNATIVES

This section outlines the processes in which remedial alternatives were developed for the Summitville Mine site final remedy and presents a description of each alternative. A comparative analysis among the preferred remedial alternatives is also presented using criteria set forth in the NCP.

A Feasibility Study Technical Memorandum (Rocky Mountain Consultants, Inc., 2000) was prepared that served as the initial step towards preparation of a Feasibility Study, and ultimately, the final Record of Decision for the site and downstream study areas. The Technical Memorandum identified general response actions, which are general categories of remedial technologies or process options, that are taken individually or in combination to satisfy the RAOs. The general response actions provided a “universe” of potential remedial technologies that were screened during the evaluation process. The result of the Feasibility Study Technical Memorandum was the development of a number of conceptual remedial alternatives. The alternatives utilized a range of remedial process options that included diversion ditches, collection ditches, dams and reservoirs, passive and active water treatment, chemical stabilization, subsurface storage, and groundwater collection systems, among others.

An Engineering Alternatives Report (Rocky Mountain Consultants, Inc., 2001a) was subsequently prepared that further refined the conceptual remedial alternatives presented in the Feasibility Study Technical Memorandum. The Engineering Alternatives Report provided a format to investigate technologies and combinations of components prior to the detailed analysis in the Feasibility Study. Comments from the CDPHE, U. S. EPA, and stakeholders together with consideration of site conditions and final reclamation (OU4) designs were used to develop 21 remedial alternatives. The alternatives were screened on the basis of cost, implementability, and effectiveness in more detail than in the Feasibility Study Technical Memorandum. An important aspect of the Engineering Alternatives Report was that it screened on a site-wide basis, not necessarily on a medium- specific basis. This analysis was undertaken to present decision-makers with a range of comprehensive components that addressed the entire site. Based on comments received from CDPHE, U. S. EPA and stakeholders, the following remedial alternatives were retained for detailed analysis in the Feasibility Study.

- Alternative 1A: No Action
- Alternative 1B: No Further Action/SDI Breach
- Alternative 2: Clean Water Diversion/New Dam Below Confluence of Wightman Fork and Cropsy Creek/Passive Water Treatment
- Alternative 3: Upgrade SDI/Existing Water Treatment Facility with Seasonal Treatment
- Alternative 4: Upgrade SDI/New On-site Water Treatment Plant with Flexible Treatment Season
- Alternative 5: New Dam Upstream of Wightman Fork-Cropsy Creek Confluence/New Gravity-Fed Water Treatment Plant with Flexible Treatment Season

6.1 Engineering Considerations

The following sections describe several engineering design elements that were considered in developing the remedial alternatives. Engineering considerations primarily focused on designs for hydrologic structures, such as ditches and impoundments, and water treatment.

6.1.1 Design Precipitation Event

Some of the alternatives have components that are based on the “design event.” The design event was used to size impoundment storage and diversion ditches, taking into account snow melt, precipitation, and runoff. The design event for remedial alternatives is based on the 100-year snow melt and 500-year 24-hour precipitation. Runoff from snow melt is the primary contributor in the design of impoundment size, whereas runoff from thunderstorms drives the design of ditches. The design event is judged to be appropriate due to the severe climate at Summitville. Rationale for the design event follows.

Summitville has an annual average of about 344 inches (29 feet) of snow. This average is based on data from a 21-year period of record from 1939 to 1947 and from 1986 through 1999. The nearby Wolf Creek Pass station is listed as the snowiest weather station in Colorado. The runoff from the 100-year snow melt was estimated to be 82 inches. Of this amount, approximately 60 percent of the snow melt reaches the downstream boundary of the site; the balance is lost to evaporation or sublimation. Therefore, the actual runoff from the 100-year snow melt is 49 inches of water, or just over four feet (Rocky Mountain Consultants, Inc., 2001d). The snow generally melts rapidly during the months of May and June (within 60 days) and the volume of snow melt has historically exceeded the capacity of the current impoundment/treatment system (SDI/WTP) resulting in releases of contaminated water. The probability of exceeding the 100-year snow accumulation over a 100-year period is 63 percent.

The current hydraulic design for the OU4 surface run-off ditches and the minimum State of Colorado Engineer's Office (SEO) requirement for the SDI spillway is the 100-year, 24-hour precipitation event. However, it is often necessary to design ditches for larger events due to the severity of the climate at Summitville. For example in 2000, despite the relatively low snow pack, overtopping of some site ditches occurred in late spring. Due to the northern aspect of many site ditches, snow and ice "bridges" may remain in the ditches up to late spring, greatly reducing the hydraulic capacity during spring snow melt. The saturated and partially frozen conditions that exist during, the snow melt require that ditches be designed for a larger event (i.e., 500 year) to provide a greater factor if safety against over-topping or breaching. The 500-year 24-hour thunderstorm was estimated to be 3.8 inches and the 100-year 24-hour thunderstorm was estimated to be slightly less at 3.2 inches (Rocky Mountain Consultants, Inc., 2001d). The recurrence interval of the 500-year thunderstorm is only 18 percent over a 100- year period. Because of the potential for snow and ice accumulation in site ditches and the low recurrence interval, several of the hydraulic structures have been preliminarily designed to pass the 500-year thunderstorm.

6.1.2 Hydrologic Basins

To evaluate the effectiveness of the remedial alternatives, the size of hydraulic structures, such as impoundments and diversion ditches, had to be specified. Accordingly, five design event hydrologic basins were delineated to determine the required capacities of the structures (Figure 6-1). Minimizing or eliminating controlled releases of contaminated water from the SDI was the primary criteria for using the design event in the preliminary sizing of an on-site impoundment in the remedial alternatives. In other words, the structures were sized with sufficient capacity to ensure that contaminated water would not be released in the event of a 100-year snow melt and 500- year thunderstorm. Water quality data show that releases of contaminated water from the SDI dramatically depresses the pH of Wightman Fork. The depressed pH conditions can persist for several weeks.

The design of a dam for the contaminated water storage impoundment considered: 1) the design event criteria as discussed above, and 2) SEO Dam Construction and Safety Regulations for spillway sizing. Because the design event is larger than the current hydraulic capacity of some of the OU4 ditch system (100-year storm event), the basin boundaries were constructed to reflect components of the alternatives (ditch upgrades, proposed impoundment locations, or pipelines). The sizing of the basins was necessary because some alternatives consider the possibility of the success or failure of the revegetated areas to produce clean surface run-off. A description of each basin follows (Figure 6-1).

- Full Basin: Contains approximately 2,726 acres of Cropsy Creek and Wightman Fork watershed above the current SDI location.

- Disturbed Area Basin: Contains approximately 572 acres within the originally permitted 1,231-acre mine site, most of which is composed of areas disturbed during recent and historic mining operations.

- Disturbed Area Excluding Cropsy Valley Sub-Basin: Contains approximately 418 acres of the Disturbed Area Basin (Cropsy Valley Sub-Basin contains approximately 154 acres).

- Highwall Sub-Basin: The exposed high sulfide-bearing rock and waste rock of the Highwall contains approximately 40 acres.

- Beaver Mud Dump/SDI Sub-Basin: The reclaimed slopes of the Beaver Mud Dump and the surface area of the reservoir contain approximately 28 acres.

During most of the treatment season and for years with normal or below normal snow pack, the current OU4 surface runoff ditch system effectively divides the site into three hydrologic basins. A description of each of the existing OU4 hydrologic basins follows (Figure 6-2).

- Basin A: The approximate 208 acres includes the North Waste Dump, Missionary Seeps, Reynolds Adit, and the Beaver Mud Dump/SDI areas.

- Basin B: The approximate 316 acres includes the Upper Cropsy Valley, the Heap Leach Pad/Dike No. 1 footprint, and the downstream slopes of the SDI.

- Basin C: The approximate 168 acres includes the Highwall, mine pits, and Cyanide Destruction Plant areas.

Basins A and C account for approximately two-thirds of the disturbed areas and, since 1997, contaminated water from these areas have been diverted to the SDI for treatment. Surface runoff from Basin C has been routed to the SDI via the P1 culvert. Beginning in 2001, water quality is being monitored at the P1 culvert (surface water monitoring point L3-1) during the spring runoff as part a water management program. If the water quality is better at L3-1 than at WF 5.5, or if the SDI cannot maintain a maximum water elevation of six inches below the spillway, Basin C untreated water is discharged into Cropsy Creek, via Ditch R.

6.1.3 Water Treatment

Several water treatment technologies for metals removal, both active and passive, were evaluated when developing remedial alternatives. The following summarizes the treatment processes and their potential applicability to the final site-wide remedy.

6.1.3.1 Chemical Precipitation

Conventional treatment with lime, or sodium hydroxide, is widely used to treat acid mine drainage at mine sites in the Rocky Mountain States and elsewhere. This type of a treatment technology is well understood and proven to be effective for metals removal.

6.1.3.2 Ceramic Micro-Filtration

Ceramic microfiltration is a physical separation process that uses a filter to remove particles greater than 0.2 microns. The process begins with the addition of a sodium hydroxide solution that raises the wastewater pH to between 8.5 and 9.5. At this pH, many metals form insoluble or low-solubility hydroxides or oxides that precipitate and can be filtered from solution. Basically, the ceramic microfiltration unit replaces the clarifier in a water treatment plant configuration. This technology has the potential for reducing the volume of sludge generated by a conventional treatment plant by 35 to 50 percent. If lime is used for pH adjustment instead of sodium hydroxide, the reduction in sludge may be more in the range of 10 to 15 percent. Consequently, this system will be considered as part of the final remedy at the site.

6.1.3.3 Passive Treatment

Three passive water treatment technologies were tested at the site during the 2000 field season. These technologies include: Successive Alkalinity-Producing Systems; Aquifix System; and Zeolite Systems. Discharge from the Reynolds Adit or the Reynolds Adit pipeline was used as influent to these passive systems. Although preliminary results of these passive treatment technologies indicate relatively high removal rates for some metals, their ability to treat the large volume of acid mine drainage generated at the site is limited because of the limited flat-lying terrain required by the systems. Furthermore, the severe cold and snow would limit operation of passive treatment systems to only 4 to 5 months of the year. the treatment plant. The design volume is based on an annual production of 4,000 cubic yards over a 5-year period. near the current site entrance and head east, rejoining Park Creek Road near an elevation of 11,250 feet MSL.

6.2 Description of Remedial Alternatives

This section of the Record of Decision describes each remedial alternative. Significant issues related to the alternative are presented.

6.2.1 Alternative 1A: No Action

The No- Action alternative is included to provide a baseline against which other technologies can be compared. Implementation of the No-Action alternative dictates that no other alternatives or responses be implemented at a source following the completion of the interim remedial actions. Unaddressed contaminated sources would remain at the site with no plans for future control or removal. The No-Action plan assumes that the O&M for the site would be limited to monitoring of significant structures (e.g., annual inspections of ditches, dikes, etc.) and limited site maintenance. Significant issues associated with this alternative include the following:

- No water treatment technologies are utilized,
- Contaminated sediments would not be impounded or restricted from migrating offsite,
- The mine pool would not be regulated, and
- The environment downstream of the site would continue to be adversely impacted.

Another significant issue of the No-Action alternative is that the SDI would remain in place. The SEO requires that the spillway of the SDI be upgraded to pass the 100-year flood, even though it is currently designed to pass only the 25-year flood. By leaving SDI in its current condition, erosion along the spillway could develop that may eventually compromise the integrity of the dam. This could potentially lead to failure of the dam and unsafe conditions. If the spillway is not upgraded, the SEO would require the dam to be breached. Because neither upgrading of the spillway or breaching the dam is considered in this alternative, the No-Action alternative would fail to comply with the SEO Dam Safety and Construction Regulations.

6.2.2 Alternative 1B: No Further Action/SDI Breach

The No Further Action alternatives is included to provide an additional baseline against which other technologies can be compared. The No Further Action alternative dictates that no other alternatives or responses be implemented at a source following the completion of the interim remedial actions. As with Alternative 1A, unaddressed contaminated sources would remain at the site, with no plans for future control or removal. Capital costs would be limited to those actions necessary to leave the site in a safe condition and to facilitate monitoring. The No Further Action assumes that the O&M for the site would be limited to monitoring of significant structures (e.g., annual inspections of ditches, dikes, etc.). Significant issues associated with this alternative include the following:

- No water treatment technologies are utilized,
- Contaminated sediments would not be impounded or restricted from migrating offsite,
- The mine pool would not be regulated, and
- The environment downstream of the site would continue to be adversely impacted.

Unlike Alternative 1A (No Action), Alternative 1B considers some additional capital expenditures, primarily those necessary to leave the site in a safe condition. Breaching of the SDI dam is included to comply with SEO dam safety regulations, in addition to building demolition and limited rehabilitation of the Reynolds and Chandler Adits.

6.2.3 Alternative 2: Clean Water Diversion/New Dam Below Confluence of Wightman Fork and Cropsy Creek/Passive Water Treatment

A 2,503 acre-foot impoundment would be created by a new dam constructed downstream of the confluence of Cropsy Creek and Wightman Fork. The two main assumptions of this alternative are: 1) the revegetated disturbed areas of the site do not adequately reduce metals loading; and 2) impounded waters are passively treated prior to discharge into Wightman Fork by increased retention time, precipitation, and adsorption in a large-capacity impoundment. Dilution will also lower metals concentrations. No active water treatment would occur at the site. The impoundment would inundate U. S. Forest Service land and would require the purchase of water rights to impound 2,503 acre-feet of water. The dam would be designed store the 500-year thunderstorm and 100-year snow melt (design event) from the disturbed area of the site (572 acres). Clean surface water from upstream of the site would be diverted around the impoundment by upgrading Wightman Fork and Cropsy Creek diversions for the design event. Significant issues associated with this alternative include the following:

- Obtaining water rights to impound up to 2,503 acre- feet of water,
- Inundating U. S. Forest Service land,
- The success of OU4 reclamation in reducing contaminated drainage is not critical, and
- The effectiveness of a large impoundment is unproven for year- round treatment of acid mine drainage at high altitudes.

6.2.4 Alternative 3: Upgrade SDI/Existing Water Treatment Facility with Seasonal Treatment

This alternative evaluates the long-term operation of the existing treatment plant, impoundment, and ditch system. It is essentially a continuation of the status quo operation of the site. The SDI would be upgraded to meet the SEO’s minimum requirements for a Class III dam and would maintain its current storage capacity. The OU4 ditch system would not be modified. The SDI would receive water as currently designed from OU4 hydrologic Basin A and sometimes Basin C (total of 376 acres), excluding the Cropsy Creek Basin. Excess untreated water would have to be released from the SDI. The existing pumpback/ barge is retained as the influent delivery system. Use of the existing pumpback system would limit water treatment to about six months of the year (i.e., May through October). The current water treatment operations would continue with the existing plant. Significant issues associated with this alternative include the following:

- Releases of contaminated water from the SDI to Wightman Fork would continue during years with at least average snow pack,
- The existing influent delivery system is problematic and requires considerable O&M,
- The water treatment period is limited due to the severe climate preventing access to the barge pumpback system and removal of sludge,
- Long-term regulation and management of the mine pool may not be possible because of insufficient capacity of the SDI,
- The mine pool would not be managed, and
- Adits and their plugs would continue to deteriorate.

6.2.5 Alternative 4: Upgrade SDI/New On-Site Water Treatment Plant with Flexible Treatment Season

Alternative 4 addresses the same significant issues identified in Alternative 3, (i.e., releases of untreated water from the SDI, collection of currently untreated sources, the efficiency of the water treatment plant, and the unreliability of the pumpback system). Alternative 4 does not consider the construction of a new dam or increased storage capacity.

The SDI would be upgraded as in Alternative 3, but rerouting of on-site surface water would allow the storage of the design event (500-year thunderstorm and 100-year snow melt) without increasing capacity.

The upgrade of Ditches P and L2 would reduce the hydrologic basin tributary to the SDI to areas including only the Highwall and the Beaver Mud Dump/SDI Sub-Basins (68 acres). Also, the SDI would be designed as a Class II dam capable of passing one-half of the probable maximum precipitation. Alternative 4 assumes that OU4 is entirely effective at reclaiming the disturbed area of the site (504 acres) and produces adequately clean surface water discharges. The SDI could not store additional drainage from areas of the site where reclamation has not been successful at reducing acid mine drainage. U. S. BOR (1998) estimated that OU4 reclamation efforts will be, at best, 95 percent successful. This would leave at least five percent of the total area inadequately neutralized. Alternative 4 would fail to store contaminated runoff from the remaining five percent.

A new water treatment plant would be constructed on the right (southern) abutment of the SDI at an elevation of approximately 11,250 feet MSL, approximately 30 feet above the normal high water line of the SDI. The new treatment plant would have a 1,000 gpm treatment rate. A permanent reinforced concrete wet well and pump would deliver water to the new treatment plant. Significant issues associated with this alternative include the following:

- The impoundment could not store additional drainage from areas where OU4 reclamation is not successful and still contain the design event;
- The influent delivery system is more reliable than the current system, but it would still require operation and maintenance; and
- The WTP could have a flexible treatment season, however, wintertime operation could be problematic with a pumpback delivery system for influent.

6.2.6 Alternative 5: New Dam Upstream of Wightman Fork-Cropsy Creek Confluence/New Gravity-Fed Water Treatment Plant with Flexible Treatment Season

Alternative 5 considers the construction of a new dam to address the significant issues that remain from Alternative 4. Specifically, Alternative 5 would provide a more reliable WTP influent delivery system and increased impoundment capacity for storing acid mine drainage from the site.

An approximate 405 acre-foot impoundment would be created as a result of a new dam being constructed between the current SDI location and the confluence of Cropsy Creek and Wightman Fork. The outlet works would be constructed to provide a gravity-fed influent source for the new treatment plant. The dam would be designed to store the design event and pass one-half the probable maximum precipitation. The increased capacity of the impoundment, of approximately 100 acre-feet, would also allow for storage of up to two- thirds of the drainage from the entire disturbed area basin at times other than when the design event is exceeded. Therefore, OU4 reclamation efforts could be as little as 30 percent effective and this alternative would still allow RAOs to be met.

A new, conventional 1,000 gpm water treatment plant would be constructed downstream of the SDI. The water treatment plant would operate seasonally, April through October, with the capability to be operated year-round, if necessary. The existing SDI and WTP will continue to operate during the construction of the new dam and the new water treatment plant. Following construction of the new dam, the SDI dam would be removed and impounded water would be routed by gravity flow to the new downstream treatment plant. Significant issues associated with this alternative include the following:

- Allows for storage of additional drainage from areas where OU4 reclamation may not produce adequate water quality;
- Uses a more reliable, gravity flow influent delivery system that requires less O& M; and
- The new WTP would have a flexible treatment season that is more reliable because of its gravity-flow delivery system.

6.3 Assessment Criteria

A comparative analysis of remedial alternatives is presented in Section 6.4. Criteria used to assess each of the remedial alternatives are described in the following subsections.

6.3.1 NCP Criteria

Assessment of remedial alternatives was performed using the general rules identified in CERCLA § 121 and the nine evaluation criteria specified in the NCP (40 C.F.R § 300.430(f)(5)(i)). The nine assessment criteria are described as follows:

- Overall protection of human health and the environment - This criterion considers the overall short-and long-term protection of human health and environment from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposure.

- Compliance with ARARs - This criterion considers whether and how alternatives meet applicable or relevant and appropriate Federal and State requirements, and whether any ARAR waivers are appropriate.

- Long-term effectiveness and permanence - This criterion refers to the long- term effectiveness and permanence an alternative affords, along with the degree of certainty that the alternative will prove successful. Factors that are considered, as appropriate, include the magnitude of residual risks remaining from untreated waste or treatment residuals remaining at the site upon the completion of the remedial activities, the characteristics of the residuals that remain, and the adequacy and reliability of controls, such as containment systems and institutional controls, that are necessary to manage treatment residuals and untreated waste.

- Reduction of toxicity, mobility, or volume through treatment - This criterion refers to the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume of hazardous substances found at the site, including how treatment is used to address the principal threats posed by the site contaminants.

- Short-term effectiveness - Short-term impacts are assessed considering the short-term risks that might be posed to the community during implementation of an alternative (i.e., during the remedial action), potential environmental impacts of the alternative and the effectiveness and reliability of mitigative measures during implementation.

- Implementability - This criterion refers to the ease or difficulty of implementing the alternatives considering the technical feasibility, administrative feasibility, and availability of services, materials, and resources.

- Cost - This criterion requires an evaluation of the total cost associated with implementing the alternative. These include capital costs, both direct and indirect costs, annual operation and maintenance costs, and net present value of capital and operation and maintenance (O&M) costs.

- State acceptance - This criterion requires providing the State s substantial and meaningful involvement in the remedy selection process. It includes the State's position and key concerns related to the preferred alternative and other alternatives, as well as the State's comments on ARARs or any proposed ARAR waivers.

- Community acceptance - This criterion requires an evaluation of the comments received on the remedial alternatives under consideration from all interested parties.

6.3.2 Estimation of Costs

Estimating the cost of remedial alternatives was performed in accordance with U. S. EPA guidance (U. S. EPA, 1988) . The accuracy of cost estimates is anticipated to fall within the acceptable range for typical feasibility study evaluations of + 50 percent to -30 percent. Unit costs were developed from actual unit costs for construction activities from contractors working at the site, actual unit costs from contractors performing similar construction activities, costs for similar construction activities reported in the literature or vender quotes, or the 2000 Means Heavy Construction Cost Data, adjusted for remote, high altitude conditions.

Total alternative costs for the final remedy would occur over two phases: 1) Remedial Action; and 2) long-term O&M. The Remedial Action phase includes the Remedial Design, remedy construction, and a period of up to 10 years of operation and maintenance after the remedy becomes "operational and functional" or after the "Remedial Action is complete," whichever is earlier (40 CFR § 300.435(f)(3)). Upon conducting the Remedial Action phase, the long-term O&M begins and the financial responsibility to maintain the protectiveness and effectiveness of the final remedy would shift from the Federal government to the State. Alternatives were evaluated for capital, periodic, and O&M costs for both the Remedial Action and long-term O&M phases.

Capital costs consist primarily of expenditures incurred to build or install the Remedial Action. Capital costs are estimated exclusive of costs required to operate or maintain the action throughout its lifetime.

Operation and maintenance costs are those post construction costs necessary to ensure or verify the continued effectiveness of a remedial action. These costs are estimated on an annual basis. The O&M costs occur over the entire period of analysis and are therefore identified for both the Remedial Action and long-term O&M phases.

Periodic costs are those costs that occur only once every few years or expenditures that occur only once during the entire O&M period or period of analysis. These costs may be either capital or O&M costs, but because of their periodic nature, it is more practical to consider them separately from other capital or O&M costs in the estimating process. Periodic costs include the future costs, subject to a discount factor, of replacing remedy components (e.g., new bulkhead or new water treatment plant once every 33 years), site reports, and updates to institutional controls.

6.3.3 Project Life

Due to the likelihood of continued acid mine drainage from the site, a 100-year period of analysis was used for the analysis of alternatives. The 100-year period includes the Remedial Action phase, from planning to project completion, years 1 through 10 (i.e., 2001 through 2011), and the maintenance of the remedy during the long-term O&M phase, years 11 through 100 (i.e., 2011 through 2101).

6.3.4 Discount Factor

A present worth analysis was performed for each remedial alternative. A discount factor was applied to itemize expenditures for each of the alternatives that occur beyond the base year (2001) over the period of analysis. All costs for the alternatives during the period of analysis are related to a common base year. This allows the cost of the final Remedial Action to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the Remedial Action and O&M over its planned life.

In conducting the present worth analysis for future costs, assumptions must be made regarding the discount rate and the period of performance. The final alternative total cost is highly sensitive to the selection of the discount factor due to O&M and periodic costs over the period of analysis. In general, a discount rate of 7.0 percent is used to estimate the present value of future costs for Federal facilities. However, Office of Management and Budget Circular No. A-94 suggests a different discount rate for sites that meet certain criteria. The criteria include the following:

- Future year expenditures will be high,
- Costs are sensitive to the discount rate, and
- Cost will continue beyond 30 years.

The site meets all three of these criteria. For sites using Superfund authority, Circular No. A-94 suggests using a discount rate of 4.2 percent. A 4.2 percent rate was used because it was judged to be the most representative of the actual discount rate over the 100- year period of analysis.

6.4 <u>Comparative Analysis of Remedial Alternatives</u>

Remedial alternatives for the site were evaluated relative to one another in a comparative analysis. The purpose of a comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another using established criteria in the NCP. The alternative that performs the best overall in each criteria is discussed first, followed by other alternatives in the relative order in which they perform. Table 6-1 provides a summary of the comparative analysis for each assessment criterion.

6.4.1 Overall Protection of Human Health and the Environment

As reported in Baseline Human Health Risk Assessment (Morrison Knudsen Corporation, ICF Kaiser Engineers, Inc., 1995a) and the Public Health Assessment (ATSDR, 1997), the site does not pose a risk to human health. This determination was based on water quality data collected in 1994 and 1995. It should be noted that this risk assessment was conducted in years when diversion ditches at the site had not been constructed to route water to the SDI and the water treatment facility was not operating at its current rate of 1,000 gpm. Considerable improvement in water quality has been evident in the Alamosa River and Terrace Reservoir since that time. Therefore, the combination of an impoundment and active water treatment (Alternatives 3, 4 and 5) would continue to be protective of human health. The level of protection of human health in Alternative 2 cannot be accurately assessed because the technology has an unknown level of contaminant reduction (there are no known passive treatment systems of this type at mine sites), but it is expected to be less than Alternatives 3, 4 and 5. Alternatives 1A and 1B could potentially pose adverse risks to human health because active water treatment is not employed

In terms of environmental protection, Alternative 5 offers additional impoundment capacity and the greatest level of protection of all alternatives. Additional storage capacity in Alternative 5 further reduces the possibility of untreated water being released from the on-site impoundment and it has the ability to store and treat water from additional portions of the site, should OU4 revegetation attain no more than 95 percent success in neutralizing contaminated soils. Alternatives 3, 4, and 5 utilize active water treatment. However, the alternatives differ in the efficiency of running the treatment plant. Alternatives 4 and 5 would operate similar, more efficient and reliable treatment plants than Alternative 3. Therefore, Alternatives 4 and 5 would provide a greater level of environmental protection than Alternative 3. Alternative 2 provides the greatest storage capacity, but it relies on large-scale passive water treatment that is an unproven technology at the site. Therefore, Alternative 2 would be less protective than Alternatives 3, 4, and 5. Alternatives 1A and 1B would not be protective of the environment. These two alternatives would allow significant quantities of contaminated water and sediment to migrate downstream.

6.4.2 Compliance with ARARs

For each of the alternatives, compliance with State and Federal water quality ARARs is dependent on the success of OU4 reclamation and the ability to store contaminated water generated at the site. Taking this into account, Alternative 5 would have the greatest ability to achieve water quality ARARs. The added capacity of the impoundment and the ability to route more drainage to the treatment facility would minimize the metals load to Wightman Fork. While Alternative 5 assumes that reclamation is no better than 95 percent successful in neutralizing contaminated soils, the increased storage capacity would allow for some additional storage and treatment drainage from reclaimed areas that may continue to produce acid mine drainage.

The SDI upgrade in Alternative 4 and routing of clean water also would reduce the frequency of untreated releases from the SDI to Wightman Fork. Alternative 4 assumes that reclamation is 100 percent successful and the impoundment would fail to store additional drainage from reclaimed areas that continue to produce acid mine drainage. Therefore, Alternative 4 would have a lower probability of meeting water quality ARARs than Alternative 5.

Alternative 3 would continue to release untreated water from the SDI to Wightman Fork during normal or above snowpack, which would have adverse effects on the downstream ecosystem. Alternative 3 is considered to have a lower compliance with water quality ARARs than Alternatives 4 and 5, because certain sources would not be collected. Based on current data, a failure to collect these sources would result in exceedences of water quality standards.

The ability of Alternative 2 technology to comply with water quality ARARs has not been documented or proven at any known mine site. Water would have to be released to offset consumptive losses (i.e., evaporation) and to maintain downstream senior water rights. The quality of water in the impoundment when releases have to be made could be highly contaminated. When this is considered, Alternative 2 is expected to have a low probability of comply with water quality ARARs.

Results of reactive transport modeling of the Alamosa River conducted by the U. S. Geological Survey (USGS, 2001), were used to assess the compliance of the alternatives with respect to achieving the specific aquatic life water quality standards, Classifications and Numeric Standards for the Rio Grande Basin (CDPHE, 1998). Copper is the primary chemical of concern in the Alamosa River system downstream of Wightman Fork, and its presence in the surface water system is predominantly due to releases from the site. Therefore, the impacts the remedial alternatives have on downstream water quality focuses on copper.

The model results suggest that actions taken at the site under Alternatives 4 and 5 would meet the copper standard in the Alamosa River below Jasper under high-flow conditions. Standards would not be met under high- flow conditions for Alternative 3. The low-flow model predicted copper concentrations in excess of the chronic and acute standards for all alternatives, although Alternatives 4 and 5 have a much higher probability of achieving this ARAR under low flow conditions than Alternative 3. Alternative 3, in turn, has a higher probability of meeting the water quality ARAR than Alternatives 1A, 1B or 2.

All alternatives, except Alternative 1A, would comply with State ARARs for dam safety.

Alternative 1A would leave the SDI in place without either upgrading the spillway or breaching the dam, which would not comply with SEO Dam Safety and Construction Regulations.

6.4.3 Long-Term Effectiveness and Permanence

Alternatives with the ability to divert or store surface runoff and groundwater from the site provide the most assurance of long-term effectiveness. Alternatives that would allow uncontrolled or controlled releases of untreated water from the on-site impoundment were considered to have a low long-term effectiveness.

The new impoundment and upgrading of ditches in Alternative 5 provides the most protective engineering controls for management of contaminants from the site on a long- term basis. Furthermore, reclamation is estimated to be up to 95 percent successful in neutralizing contaminated soils and the larger impoundment capacity of Alternative 5 could store drainage from areas where reclamation has not been effective. The reliability of Alternative 5 is the highest among all alternatives.

Alternative 4 is also capable of storing and treating the design event. However, without increasing the storage capacity of the SDI, contaminated water not mitigated by OU4 reclamation could not be stored without impinging on the ability of the SDI to contain the design event. Therefore, Alternative 4 was considered to have a lower long-term effectiveness than Alternative 5.

The long-term effectiveness of Alternative 3 is lower than Alternatives 4 and 5, primarily because of its inability to accept additional drainage from reclaimed areas that may continue to produce acid mine drainage. Alternative 3 is essentially the status quo that has proven ineffective in years when normal or above normal precipitation occurs at the site.

The long- term effectiveness of Alternative 2 is unproven. It relies on large-capacity passive treatment. Passive treatment on such a large scale has not been implemented at any high altitude mine sites, and thus, its long-term effectiveness is speculative at best. It is reasonable to assume that Alternative 2 would have a lower long-term effectiveness than alternatives that incorporate proven, conventional water treatment technologies because active water treatment can deliver 99 percent contaminant reduction, and passive water treatment can not reliably achieve this same level of performance.

For the alternatives that employ active water treatment, Alternatives 4 and 5 would have a higher long-term effectiveness than Alternative 3. This greater long-term effectiveness is due to both alternatives coupling construction of new treatment facilities with modernized equipment and delivery systems that are more reliable. The modern aspect of the treatment facilities translates into a higher level of long-term effectiveness. The existing water treatment plant retained by Alternative 3 has exceeded its service life and it is expected to have equipment breakdowns with increasing frequency.

Results from the USGS reactive transport model of the Alamosa River were used to evaluate the relative long-term effectiveness of the remedial alternatives. Predicted concentrations were compared for the concentrations at station AR41.2, which is located in the Alamosa River below Jasper, near the upstream end of Stream Segment 3c. The weighted ranking of the remedial alternatives under low- and high-flow conditions for the four risk driver parameters (i.e., chemicals of concern) is summarized in the table below. In these summary tables, 1 indicates the model predicted the lowest metal concentration or highest pH, while a 5 indicates the highest predicted metal concentration or lowest pH. Where two alternatives provided the same result, they were given the same ranking.

Alternative	*Relative ranking under Low-Flow Conditions*				*Average Ranking*
	Copper	*Zinc*	*Iron*	*pH*	
1A/1B	5	5	5	5	5
2	4	4	4	4	4
3	3	3	3	3	3
4	2	2	1	1	1.5
5	1	1	1	1	1

Alternative	*Relative ranking under High-Flow Conditions*				*Average Ranking*
	Copper	*Zinc*	*Iron*	*pH*	
1A/1B	5	5	5	5	5
2	4	3	1	4	3
3	3	4	4	3	3.5
4	2	1	2	1	1.5
5	1	1	2	1	1.25

The modeling indicates that Alternative 5 consistently provided the lowest metals concentration and highest pH, although the Alternative 4 results were not that much different. Alternatives 1A/1B consistently finished last. While Alternative 3 outperformed Alternative 2 under low-flow conditions, Alternative 2 had higher ranking for zinc and iron under high-flow conditions.

6.4.4 Reduction of Toxicity, Mobility, or Volume of Contaminants

Alternatives 3, 4, and 5 include conventional water treatment. The effectiveness of this technology has been documented by the operation of the existing WTP. Between the years 1997 and 1999, the WTP annually removed an average of 55,000 pounds of copper from site water prior to its discharge into Wightman Fork. Without an impoundment and water treatment, this load would be added directly to Wightman Fork and the Alamosa River on an annual basis, although the load would be somewhat reduced by OU4 reclamation.

Because Alternatives 3, 4 and 5 incorporate the same water treatment technologies, their ability to reduce the toxicity of site contaminants is approximately the same. These alternatives can be differentiated, however, by their ability to reduce the mobility and volume of site contaminants. This differentiation is illustrated by comparing the impoundment size and drainage basin in each alternative. The existing SDI, (Alternative 3) has been unable to store runoff from the site during years of average to above average precipitation. Alternative 4 assumes that OU4 reclamation is entirely effective, but some (five percent) unsuccessfully reclaimed areas are expected to occur. This additional water could be routed to the SDI, but it would compromise the ability of the SDI to contain the design event. Adding this contaminated water would increase the chance of releasing untreated acid mine drainage and sediment from the site. Alternative 5 has the ability to store the largest volume of drainage of the three alternatives employing active water treatment. Alternative 5 is more robust than Alternatives 3 and 4, because it could store and treat drainage from additional areas of the site, where reclamation has not been successful in reducing acid mine drainage. Therefore, Alternative 5 is considered to have the highest degree of contaminant mobility and volume reduction.

The impoundment in Alternative 2 could potentially store the largest volume of site drainage, but it is unlikely that it could passively treat this volume. Passive treatment using a large-capacity impoundment has not been proven at any known high-altitude mine sites. Therefore, Alternative 2 was considered to be less reliable than Alternatives 3, 4, and 5 at reducing toxicity, mobility, or volume of contaminants because it relies on an unproven treatment technology. Periodic releases of unknown water quality would be made in Alternative 2 to meet senior water rights. Alternatives 1A and 1B would provide little, if any, reduction of toxicity, mobility, or volume of contaminants. Active water treatment is not employed in these two alternatives to treat acid mine drainage from the considerable point and non-point sources that will remain at the site after reclamation is complete.

Another comparison of the reduction in mobility and volume of site contaminants can be made by evaluating each alternative’s ability to manage and treat the water in the mine pool. Alternatives 2 through 5 contain impoundments and that can be used to store mine pool water for eventual treatment. Alternatives 4 and 5 are considered to have a greater ability to treat mine pool water than Alternatives 2 and 3, because of their improved active water treatment facilities. The improved water treatment facilities will be capable of treating the higher metal concentrations from the mine pool. The larger impoundment in Alternative 5 could store additional water if the Heap Leach Pad required detwatering to improve stability and avert possible releases of contaminants. The mine pool could not be managed and treated in Alternatives 1A and 1B.

Managing surface water to reduce the frequency of untreated releases to Wightman Fork is incorporated into Alternatives 4 and 5. However, only Alternatives 2 and 5 provide storage for additional amounts of contaminated water from portions of the site where OU4 reclamation has not been entirely effective. Of these two alternatives, Alternative 5 has the lowest probability of releasing untreated water because of its proven, conventional water treatment technology. Alternative 2 technology is unproven. Acid mine drainage would discharge to Wightman Fork in Alternatives 1A and 1B.

Sludge is an end product of conventional water treatment processes. No sludge would be generated in Alternatives 1A and 1B, as water treatment is not employed. Metals will accumulate in the large-capacity impoundment in Alternative 2 from the processes of metal precipitation and settlement; however, the volume of accumulated metals is not known at this time. Alternatives 3, 4, and 5 employ active water treatment that will produce sludge. Alternatives 4 and 5 include new water treatment plants that will use modernized equipment and possibly new treatment technologies. These improvements should result in a reduced production of sludge, compared to Alternative 3 that uses the existing water treatment plant. The volume of sludge generated in Alternatives 4 and 5 is expected to be similar.

The reduction in post site-wide remediation copper loads exiting the site for each alternative was compared using a geochemical model. For each of the alternatives, the flow and chemistry for sources at the site under both low-flow and high-flow conditions was estimated. The metal speciation equilibrium model, MINTEQA2, was used to develop post site-wide remediation loads for each of the remedial alternatives at the downstream site boundary, surface water station WF5.5.

The predicted copper loading under both low- and high-flow conditions for each alternative are compared in the table below.

Flow Regime	***Predicted Copper load at WF5.5 (pounds/day)***				
	Alternative 1A/1B	***Alternative 2***	***Alternative 3***	***Alternative 4***	***Alternative 5***
Low Flow	140	95	14	4.6	4.4
High Flow	620	408	249	87	77

Alternative 5 had the lowest predicted copper load under low- and high-flow conditions. The predicted copper loads for Alternative 4 were slightly higher than Alternative 5. The predicted low- and high-flow copper loads for Alternative 3 were about 30 percent greater than Alternatives 4 and 5. Copper loads further increased for Alternative 2, with copper loads in Alternative 1A/1B being the greatest.

6.4.5 Short-Term Effectiveness

Alternatives 2, 3, 4 and 5 would maintain the effectiveness of the current SDI/ WTP system as this system would not be taken off-line until construction of the preferred alternative is complete and ready for operation without interruption. However, during implementation of each alternative, construction activities along Wightman Fork could degrade water quality on a short-term basis. Alternative 3 would have a moderately high short-term effectiveness because, since it maintains the status quo, disturbances within Wightman Fork would be minimal. Alternative 4 would have a slightly lower short-term effectiveness because a new WTP could potentially introduce contaminants in the Wightman Fork during implementation of the Remedial Action. Alternatives 2 and 5 would have an even lower short- term effectiveness because a new dam would be constructed downstream of the existing SDI and within the Wightman Fork channel, which may lead to short-term releases of contaminants from the site. The short-term effectiveness of Alternatives 1A and 1B would be the lowest because site contaminants would discharge untreated to Wightman Fork.

6.4.6 Implementability

The severe weather conditions at the site would present a challenge to all alternatives, but not to a degree that would prevent implementation of each alternative. Alternative 1A would be the easiest to implement because no actions are taken at the site. Alternative 3 would be the next easiest alternative to implement because the major components already exist or require minor modifications. The minimal upgrade of the SDI in Alternative 3 would not present significant technical challenges or require specialized labor. Alternative 1B could be readily implemented as well. Breaching of the SDI and building demolition, the two major components of Alternative 1B, could be accomplished without difficulty.

Alternatives 2, 4 and 5 would require a greater level of effort to implement. The implemetability of these alternatives is considered to be medium. The locations for the new dams and/ or water treatment facilities in these alternatives are in areas of andesite bedrock. It is assumed that this bedrock is near surface and is competent. If the bedrock proves to be incompetent, the structures can be engineered accordingly without appreciable difficulty. Of these three alternatives, Alternative 4 would be the easiest to implement because a new dam is not proposed. Alternative 2 would probably have the lowest implementability of the three alternatives because of the large dam that would require significantly more materials for construction than the other two alternatives.

Impoundment of water is a component of each alternative except Alternative 1B and water rights will have to be secured to fill the impoundment. The Alamosa River is over-appropriated, thus, water rights will have to be purchased. Alternatives 1A, 3 and 4 have impoundment sizes of 275 acre-feet, while Alternative 5 has an impoundment size of 405 acre-feet. Water rights for these amounts could be obtained without excessive administrative difficulty. However, purchase of water rights for the impoundment in Alternative 2 (2,503 acre-feet), which is about 17 percent of the capacity of Terrace Reservoir, would be considerably more difficult and could dramatically affect the implementation of this alternative.

Conventional water treatment has been documented to have a high reliability. Therefore, the water treatment facilities in Alternatives 4 and 5 could be implemented with a high level of reliability. The water treatment plant in Alternative 3 is considered marginally reliable because it has exceeded its service life. Use of a large impoundment to passively treat drainage from the site, as proposed in Alternative 2, is an unproven technology and is therefore considered to have a low reliability.

In terms of rehabilitation of the Reynolds and Chandler Adits, Alternatives 1A and 3 would require the least effort as rehabilitation is not a component. Adit rehabilitation is common to Alternatives 1B, 2, 4 and 5; however, in Alternative 1B, a new pipeline and control valve are not components and would therefore require less effort.

6.4.7 Cost

The table below compares the costs for individual alternatives at a discount rate of 4.2 percent.

Alternative	***Capital Cost***	***Short Term O&M and Periodic Costs***	***Long Term O&M and Periodic Costs***	***Total Present Value Over 100-Year Project Life***
1A	$ 0	$ 3,892,000	$ 5,804,000	$ 9,696,000
1B	$ 3,426,000	$ 6,144,000	$ 7,067,000	$ 16,637,000
2	$ 23,158,000	$ 4,858,000	$ 7,518,000	$ 35,534,000
3	$ 1,577,000	$ 23,950,000	$ 59,896,000	$ 85,423,000
4	$ 17,364,000	$ 16,313,000	$ 39,262,000	$ 72,939,000
5	$ 24,150,000	$ 15,677,000	$ 35,582,000	$ 75,409,000

Alternative 1A has the lowest total cost. No capital costs are incurred and only site monitoring and maintenance is conducted.

Alternative 1B has the next highest costs. The increase in costs of Alternative 1B over Alternative 1A is primarily from capital costs associated with breaching the SDI, building demolition, and adit rehabilitation.

The total cost of Alternative 2 is nearly double that of Alternative 1B. Although capital costs for construction of the large dam and impoundment are relatively high, the O&M costs are low because active water treatment is not employed.

Costs significantly increase in Alternatives 3, 4 and 5 by including an active water treatment facility and the associated O&M costs for the 100-year project life. Alternative 3 has the highest total cost of all alternatives. In Alternative 3, capital costs are low and account for less than two percent of the total cost of the alternative. However, the high O&M costs of Alternative 3 are due to the inefficiency of the existing water treatment plant and the barge/pumpback system.

The total costs for Alternatives 4 and 5 are less than Alternative 3. Capital costs increase to approximately 24 percent and 32 percent of the total costs for Alternatives 4 and 5 respectively. The increase in capital costs associated with Alternatives 4 and 5 is largely due to the construction of new water treatment plants. The capital costs for Alternative 5 are greater than Alternative 4 due to construction of a new dam. The higher capital costs for Alternatives 4 and 5, as compared to Alternative 3, are somewhat offset by the reduction in O&M costs. O&M costs in Alternatives 4 and 5 are significantly lower than Alternative 3 due to the increased efficiency of a new treatment plant. Likewise, O&M costs are further reduced in Alternative 5 by replacing the pumpback system in Alternative 4 with a gravity-fed influent delivery system.

6.4.8 State/Support Agency Acceptance

When evaluated using the NCP criteria, Alternatives 4 and 5 are nearly identical. For this reason, the U. S. EPA and the State believe that Alternatives 4 and 5 are not significantly different and can be blended into a single alternative. The capacity of the impoundment and the water treatment plant will be determined during the Remedial Design. U. S. EPA and the State do not believe that Alternatives 1A and 1B would be protective of the environment. The passive water treatment of Alternative 2 is a technology that has not been proven on such a large scale, as required by this or other CERCLA mine sites. Therefore, U. S. EPA and the State believe Alternative 2 is likely to be incapable of treating the quantity and quality of water present at the site. Alternative 3 would likely result in releases of untreated water from the SDI that would continue to adversely impact the downstream ecosystem. Further, it is the most expensive and inefficient active water treatment option, and has a high O&M cost. Alternative 3 is not supported by the agencies.

The difference between Alternatives 4 and 5 are: the size of impoundment, the location of the water treatment plant, and the influent delivery system. The agencies prefer a water treatment plant located downstream of the impoundment with a gravity-feed delivery system. The comparison of Alternatives 4 and 5 using the reactive transport model does not consider the ability to meet water quality criteria when there are untreated releases from the SDI. Because untreated releases result insignificant aquatic life impacts, having an impoundment of adequate size to prevent such releases is an important component of the final remedy. Therefore, the impoundment will be sized to store the design event, which essentially eliminates the probability of untreated releases over a 100-year project life. The determining factor in impoundment size is partially dependent on the degree of reclamation/revegetation success. The data to support sizing of the impoundment will be collected and evaluated during the Remedial Design phase, which is expected during years 2001, 2002 and 2003. The CDPHE and U. S. EPA support the Selected Remedy described in Section 7.0 of this Record of Decision.

6.4.9 Community Acceptance

During the Feasibility Study process and public comment period for the Proposed Plan, the majority of the community expressed support for Alternative 5, which would attain the highest level of protection of human health and the environment. Several stakeholders have expressed concern about remediation or management of point and non-point sources, such as Reynolds Adit, mine pool, seepage, etc. Each of these sources will be addressed by the Selected Remedy. One stakeholder group agreed that Alternative 5 would be acceptable to them, but they could not support a final remedy that did not include remediation of sediments along the Alamosa River and Terrace Reservoir. One community member supported Alternative 1B, citing that at the completion of OU4 reclamation, the site should be left in a safe condition and further remediation at the site is not warranted. Specific responses to community concerns are presented in Section 9.0.

7.0 SELECTED REMEDY

In the evaluation of remedial alternatives, CDPHE and U. S. EPA have determined that little distinction exists between Alternatives 4 and 5. Both alternatives involve water treatment and employ on-site hydrologic structures, such as the storage impoundment and ditches. The differences between the alternatives are the location of a new WTP and the storage capacity of an on-site impoundment for contaminated water. Therefore, the Selected Remedy for the Summitville Mine site is a combination of Alternatives 4 and 5.

Components of the Selected Remedy are shown on Figure 7-1. The water treatment plant for the Selected Remedy will be downgradient of the on-site impoundment such that a gravity-fed influent delivery system can be used. The decision regarding the exact location of the new water treatment plant and the size of the storage impoundment is deferred as a Remedial Design decision. Because it can take a few years for reclamation to mature, data will be collected through 2003 to assess the success of reclamation and to appropriately size the impoundment. The impoundment storage capacity and water treatment plant capacity will then be calculated based on the projected volume of runoff plus a buffer volume capacity from the site to met RAO Nos. 1, 2 and 3 and to eliminate untreated releases of contaminated water from the on-site impoundment.

The Remedial Design phase of the Selected Remedy is expected to require two years, during which time design drawings will be prepared, material specifications will be determined, and contractors will be procured. The design and construction of the final remedy will be phased. For example, the first objective is to design and build a new water treatment plant. During the initial design phase, data will be collected, analyzed, and used to support decisions for impoundment size. The time required to implement the Selected Remedy (Remedial Action phase) is expected to be two to three years. The majority of the work required to implement the Selected Remedy would be accomplished during the field season (i.e., May through October).

The Selected Remedy does not propose new institutional controls to limit or minimize exposure to contaminants. Most of the current institutional controls are in the form of posted signs warning of potential hazards of contacting surface water and these will be used in the future. The site is currently restricted to authorized personnel with access monitored by security at the entrance to the site. Similar restricted access to the site is proposed for the Selected Remedy. It will be the responsibility of the State of Colorado to maintain the effectiveness of institutional controls.

Management of the mine pool is a component of the Selected Remedy. The objective of this component is to maintain the elevation of the mine pool below the Chandler Adit to remove point sources from the Dexter, Ida, and Chandler Adits. Figure 7-2 shows a graph of copper concentrations versus mine pool elevation during a drawdown test conducted in 2000 (Rocky Mountain Consultants, Inc., 2001d). As shown on the graph, concentrations initially increased but eventually decreased by the end of the test, when the mine pool had been drained. The test showed that lowering of the mine pool will curtail seepage in the Chandler Groin area and will reduce generation of acidic drainage. Information from this short- term test, and possible additional longer-term testing and monitoring during the Remedial Design phase, would be used to estimate the optimal level and management of the mine pool. Year- round management of the mine pool may not be possible until the Selected Remedy has been fully implemented, and after U. S. EPA and the State are able to assure that sufficient capacity is available in the on-site impoundment to accommodate and treat the mine pool water.

The Selected Remedy does not include additional remedial action at the Heap Leach Pad other than continued monitoring of groundwater and the stability of earthen dikes. Monitoring of inclinometers at Dike No. 1 over the past year has shown no appreciable subsurface movement. Modeling of Dike No. 1 also found it to be stable. Results from the Heap Leach Pad pumping test conducted in 2000 (Rocky Mountain Consultants, Inc., 2001d) showed that the water within the Heap Leach Pad is substantially isolated from the surrounding groundwater system and that recharge through the cap is negligible. The water within the Heap Leach Pad has a neutral to slightly basic pH, dissolved metals are only in the few mg/ L range, and cyanide concentrations are relatively low. Cyanide has not been detected in monitoring wells or seeps downgradient of the Heap Leach Pad for the past two years. For these reasons, the agencies believe that the Heap Leach Pad is not an environmental threat and no additional remedial action is warranted at this portion of the site at this time. However, the stability of Dike No. 1 and the water quality within the Heap Leach Pad will continue to be monitored in the future.

Sediment remediation along the Alamosa River and in Terrace Reservoir is not part of the Selected Remedy. The potential impact of sediments on the environment is measured by its affect on the water and the ability to sustain aquatic life. With the existing monitoring data and computer models (Rocky Mountain Consultants, Inc., 2001d), the agencies believe that meeting water quality standards in Alamosa River Segment 3c and downstream is achievable with the Selected Remedy. At the time of the five-year review, disposition of stream and reservoir sediment, in as much as it prevents attainment of RAOs, may be reconsidered. The agencies believe this is a reasonable approach given that the Selected Remedy should first be implemented on site to prevent any further releases of contaminated water or sediments coming from the site. Once the effectiveness of this remedy on downstream receptors is evaluated, U. S. EPA and the State can determine if additional CERCLA response is necessary for offsite areas.

*7.1 **Rationale for Selected Remedy***

Of the remedial alternatives that were evaluated, the Selected Remedy will be most protective of human health and the environment, have the greatest compliance with ARARs and achievement of RAOs, reduce contaminant volume and mobility, and have long-term effectiveness. The short-term effectiveness and implementability are considered to be moderate. The following summarizes the benefits and rationale for selection of this remedy:

- Releases of contaminated water from on- site impoundment will be eliminated.
- Minimizes risks to downstream ecological receptors.
- Includes a new Water Treatment Plant that employs a proven, effective, and efficient water treatment technology.
- Uses a more reliable influent delivery system that requires low O&M.
- Location of the Water Treatment Plant and gravity-fed delivery system allows for a flexible treatment season (i.e., year-round if needed) .
- Attains the highest level of protection of human health and the environment in the most cost effective manner.
- Assures stability of engineered structures.

The Selected Remedy is the most ARAR compliant of the alternatives that were evaluated, though some ARARs will be waived. ARAR waivers and justification are discussed in Section 8.2.1.

*7.2 **Description of the Selected Remedy***

A description of each of the major remedial components of the Selected Remedy is presented in the following subsections. Locations of the various remedial components (to the extent they can be determined at this time) of the Selected Remedy are shown on Figure 7-1.

1. Active Water Treatment Plant - A new, conventional water treatment plant will be constructed downstream of the on-site impoundment, outside of the 500-year floodplain. The exact location of the treatment plant will be determined in the Remedial Design phase. The new plant will be at an elevation such that sufficient pressure will be available to provide gravity operation of the plant. The existing WTP will be operated until the new plant is functional.

Experience at the site indicates that a 1,000 gpm capacity for the water treatment plant is an effective rate for drawing down the impoundment at the end of the season and for treating most of the seasonal inflow with the exception of the spring snow melt. Should other treatment rates be considered, the on-site impoundment will need to be resized accordingly (i.e., a lesser rate would require a larger dam).

Water treatment will consist of a precipitation process using lime or sodium hydroxide for pH adjustment. Copper and other heavy metals will be removed and the sludge will be dewatered mechanically. The dewatered sludge will be transported to an engineered disposal repository constructed on the North Mine Pit. Treatability studies are planned for 2001 and 2002 to determine the optimum treatment technology.

2. Storage Impoundment - An on-site impoundment will be used to store contaminated runoff water, adit flows, and seepage from the site. The dam will be located upstream of the confluence of Cropsy Creek and Wightman Fork. The size of the impoundment will be determined during the Remedial Design phase. The dam is intended to store the design event (100-year snow melt and 500-year 24-hour thunderstorm). It may be possible to upgrade and enlarge the existing SDI if it can be used safely and effectively to store the design event. The determination of the SDI's adequacy for this purpose will be made during the Remedial Design phase.

3. SDI Breach - If a new dam and impoundment are constructed, the existing SDI will be breached by conventional earth moving equipment. The breach will extend from the crest to the original Wightman Fork. Approximately 30,000 cubic yards of embankment will be removed and placed as fill for the construction of the Wightman Fork Diversion. If it is decided to upgrade and enlarge the existing SDI, breaching is not necessary.

4. Wightman Fork Diversion - A diversion of Wightman Fork is proposed to route clean waters upstream of the site around the on-site impoundment. The diversion will carry the design storm of the 500-year thunderstorm and 100-year snow melt. The diversion will flow into Wightman Fork downstream of the impoundment.

5. Upgrade of Ditches P and L2 - These ditches will be upgraded to convey the 500-year, 24-hour thunderstorm.

6. HW Ditch - The HW Ditch will be constructed parallel to and in between the toe of the Highwall and the revegetated North and South Mine Pit caps. The ditch is designed to collect contaminated runoff from the Highwall and route it to the impoundment. The ditch will be lined with a geomembrane to reduce infiltration. The ditch will flow to a pipeline that will terminate at an impact basin. An impact basin is necessary to dissipate the high hydraulic head produced when the water is piped from near the Highwall to the area near the new impoundment. From the impact basin, the water will flow to the impoundment for treatment.

7. Pipelines - Pipelines will be constructed to route contaminated water to the impoundment for treatment. Source areas utilizing pipelines include: the Highwall, the toe of Dike No. 1, seeps, the French Drain, and seeps between the North Waste Dump and Wightman Fork.

8. Sludge Disposal Repository - An engineered repository, with a capacity of up to one million cubic yards, will be constructed on the North Pit for disposal of treatment plant sludge. The clay cap on the North Pit will be recompacted to produce a clay bottom liner. The advantage of this location are that the pit lies within the mined land patented claim boundaries, and it can be

engineered to isolate sludge from the environment. The volume of sludge generated will be of the order of 2,000 cubic yards per year. The repository will contain a sludge disposal cell sized for five years of sludge generation and will be capped with a geosynthetic clay liner to reduce infiltration. Additional cells will be constructed every five years.

9. Groundwater Interceptor Drains - Groundwater interceptor drains will be constructed in areas of the site where groundwater underflow could impact surface water in Wightman Fork and Cropsy Creek. As presently envisioned, interceptor drains will be constructed along the toe of the North Waste Dump and below the Missionary Seeps area. Another location where interceptor drains will be constructed is at the toe of Dike No. l of the Heap Leach Pad.

   Trenches for interceptor drains will be excavated to bedrock. Horizontal drains will be constructed of perforated drain pipe surrounded by coarse gravel and wrapped with a non- woven geotextile fabric. Trenches for the drains will be backfilled with native soils and amended for vegetation. Water collected by the drain along the toe of the North Waste Dump and Missionary Seeps area will be routed to an impact basin near the site's entrance, and ultimately to the impoundment for treatment.

10. Relocation of U. S. Forest Service Road - The Forest Service road that follows the northern border of the site, connecting Park Creek Road and Pinos Creek Road, will be relocated to accommodate the enlarged Wightman Fork Diversion. Right-of-way will be obtained for the Forest Service.

11. Mine Pool Management - The mine pool will be managed to maintain a maximum elevation below Chandler Adit to reduce generation of acid mine drainage. An optimal level will be maintained by releasing water from the Reynolds Adit pipeline.

12. Reynolds Adit Rehabilitation and Control Valve - Rehabilitation of the Reynolds Adit will include a new concrete portal structure, a new pipeline from bulkhead to portal, a coarse gravel bed and drain pipe over the adit floor for drainage and mechanical accessibility, and replacement of all support sets and lagging. A long-term O&M plan of annual inspections and periodic replacement of deteriorated supports will then be implemented. A new control valve will be installed on the pipeline at the bulkhead with controls at the portal. The mine pool elevation will be regularly monitored using a pressure transducer, and mine pool discharge will be directed to the on-site impoundment. Discharge will be regulated either at the portal by installing a manual gate valve and flow meter, or by valves at the plug. Management of the mine pool will be accomplished by releasing water from the Reynolds Adit pipeline to the on- site impoundment. By maintaining a mine pool elevation below the Chandler Adit, rehabilitation work in the Chandler Adit will not be necessary.

13. Site Maintenance - Site maintenance will include annual costs for personnel and equipment necessary to perform day to day O&M of the various components of the final remedy. These tasks would include handling of sludge, operation of the treatment plant, maintenance of the roads and ditches, and reporting. Maintenance of interim remedial actions (OU1, OU2, and OU4) is included in the final remedy.

14. Monitoring - The goal of monitoring is to collect the necessary data to assess the effectiveness of the Selected Remedy. Monitoring of the final remedy (inclusive of interim remedies) will include monitoring of the following media, remedy components, or structures:

   On-Site

- Operation of ditches and culverts,
- Revegetation and overland runoff,
- Erosion,
- Groundwater and seeps,
- Surface water and water treatment plant effluent,
- Water levels and water quality of the mine pool and Heap Leach Pad,
- Compliance with WF-5.5 remediation levels,
- Engineered structure stability, and
- Instrumentation on Heap Leach Pad Dike 1, adits, and Highwall.

Offsite

- Water quality in Alamosa River, from just above Wightman Fork to downstream of Terrace Reservoir,
- Sediment in Alamosa River, from just above Wightman Fork to downstream of Terrace Reservoir, and
- Aquatic life in Alamosa River, from just above Wightman Fork to downstream of Terrace Reservoir.

Monitoring data for offsite water quality, sediments, and aquatic life will be evaluated in combination to assess improvements to water quality in the Alamosa River, Terrace Reservoir, and downstream. All data will be maintained by CDPHE in a database for the site. These data will be evaluated and interpreted by CDPHE on an annual basis and the results shared with the public. Collectively, these data constitute the body of data that will be used to evaluate the Selected Remedy at the five-year review.

7.3 Estimated Costs of the Selected Remedy

The calculations supporting the cost estimate for the Selected Remedy are based on the best available information regarding the anticipated scope of the remedial actions. Changes in the cost elements are likely to occur as a result of new information and data collected during Remedial Design phase, prior to implementation of the remedy. Major changes may be documented in the form of an Explanation of Significant Difference document, or an amendment to the Record of Decision. The current cost is an order-of-magnitude engineering cost estimate that is expected to be within + 50 to -30 percent of the actual project cost, as allowed by U. S. EPA guidance.

Because the Selected Remedy is a combination of Alternative 4 and 5 and because the size of the on-site impoundment will not be determined until the Remedial Design phase, costs for Alternatives 4 and 5 have been used to bracket the projected cost of the Selected Remedy. Since issuance of the Proposed Plan, however, three remedial components have been deleted. They include 1) Chandler Adit Rehabilitation, 2) Building Demolition, and 3) Rockfall Fence. The U. S. EPA and the State believe that these components are not necessary to meet RAOs. Rationale for deleting these components is presented in Section 8.7. Costs for these three components have been subtracted from the Alternative 4 and 5 costs presented in Section 6.4.7. The revised, total present value of Alternative 4 is $ 71,787,000 and $ 74,258,000 for Alternative 5. The cost of Alternative 5 is approximately $ 2,500,000 greater than Alternative 4, primarily from the increased capital cost for construction of the new dam and impoundment. Because of the similar cost of the two alternatives (which is well within the + 50 to -30 percent allowance) , a conservative approach was used to estimate the total cost of the Selected Remedy by using the cost of $ 74,258,000.

Itemized costs for the Selected Remedy are contained in Table 7-1. The total costs for the Selected Remedy are based on a project life of 100 years. A 100-year project life is justified due to perpetual point and non-point sources of acid mine drainage that will remain at the site after the Selected Remedy is implemented. A discount factor of 4.2 percent was used and judged to be appropriate considering that the remedial costs are expected to continue beyond the typical 30-year timeframe, and expenditures will be incurred to replace or repair certain remedy components over a 100- year period.

7.4 Expected Outcome of Selected Remedy

The purpose of this section of the Record of Decision is to present the expected outcome of the Selected Remedy in terms of achieving cleanup levels (remediation levels), waiving numeric water quality standards and use classifications, and resulting land and water uses. The expected risk reduction achieved as a result of the response action is also discussed.

7.4.1 Remediation Levels

As part of the evaluation of the remedial alternatives for the site, reactive transport modeling has been used to assess improvements in water quality of Wightman Fork, the Alamosa River and Terrace Reservoir. A final step of the modeling was to estimate remediation levels at the site boundary (WF5.5) that would be necessary to meet water quality standards in Segment 3c of the Alamosa River. Segment 3c is the offsite point of compliance for the Selected Remedy.

Surface water modeling was based on the WASP4 transport codes with the metal-speciation submodel, META4, to describe and control metal transformations and subsequent transport and fate. The WASP4/META4 model was previously used to support the Use Attainability Analysis in providing estimates for pre-Galactic and pre-mining conditions for the Alamosa River below Wightman Fork to Terrace Reservoir (Medine, 1997) and has subsequently been expanded to include Wightman Fork from WF5.5 to the mouth and the Alamosa River from Wightman Fork downstream to the reservoir. A separate modeling effort included the development of a three-dimensional model of Terrace Reservoir (HydroQual, 2001). These models provided a continuum of water quality analyses for the surface waters from the site to the outlet of the reservoir.

The WASP4/META4 model relies on the fundamental mathematics and solution approach contained in the equilibrium model MINTEQA2, developed by U. S. EPA (1991a). The WASP4/META4 code is a fully three-dimensional model with transportable sediment regions. The WASP4/ META4, Version 4, has capabilities for 16 simulated variables and the capability of fixed and variable pH simulation that has aided the evaluation of remedial alternatives in the Alamosa River basin. A number of physical and chemical processes that affect the transport of metals are taken into account in the model including advection, dispersion, sediment storage/release, chemical reaction, adsorption, desorption, erosion, sedimentation, precipitation, and dissolution. The model addresses reaction kinetics in that when setting up the model, reactions can be included or excluded based on whether they would occur in the allowable reaction time. This time period is determined based on the water volume and flow through of the compartments.

The modeling of Wightman Fork and the Alamosa River (Segment 3b: Wightman Fork to Fern Creek and Segment 3e: Fern Creek to Terrace Reservoir) included 31 surface water compartments along the main channels with 31 corresponding benthic compartments. For the reservoir modeling, four surface layers were utilized to represent the variability with depth with a total of 135 compartments, including the 35 benthic compartments. The detailed model compartmentalization represented the relationship between the water column and benthic region, the major point and non- point loads and the flow directions, including the interaction with the alluvial system. Model compartments were developed from information concerning the physical and chemical characteristics of stream reaches (i.e. slope, hydrology, sediment type) and locations for major tributaries and loads to the river system. Each water column was directly coupled to a benthic compartment.

The modeling addressed the water quality for ferrous iron, ferric iron, zinc, copper, aluminum, manganese, sulfate, carbonate, calcium, magnesium and cadmium. The chemical reactions used in the modeling were determined from MINTEQA2 simulations of a variety of conditions within the watershed. Ferrous iron oxidation kinetics were permitted as a function of pH and the iron concentration while iron and aluminum precipitation as oxides and/ or aluminum sulfate compounds was also allowed. Values for chemical reactions were adjusted for temperature and ionic strength using MINTEQA2 simulations. Following the detailed specification of system geometry, boundary conditions and initial conditions, the Wightman Fork-Alamosa River model was calibrated for both high-flow (June, 1999) and low-flow (October, 1998) conditions while the Terrace Reservoir model was calibrated to data collected from 1994 through 1999 (high flow: June 1995 and 1999, and low-flow: October 1994 and 1999). These data provided the most complete field monitoring data for modeling purposes. The initial calibration activity, following the balancing of flows and travel time, included the simulation of conservative substances followed by the calibration of total recoverable iron and aluminum within Wightman Fork, the Alamosa River and Terrace Reservoir. After solids were calibrated, subsequent steps included the combined calibration of reactive chemicals in both the water column and benthic regions. The results of the calibration indicated a relative percent error between observed and calculated concentrations in the river of generally less than 10 percent.

The calibrated model was used to estimate the maximum concentrations of chemicals (remediation levels) that could be discharged from the site while still meeting water quality standards within Segment 3c of the Alamosa River. Chemical inputs at the site boundary (i.e., the upstream model boundary condition), were obtained by mass balance analysis and MINTEQA2 simulations derived from estimated reductions in chemical loadings from various site sources. Estimated chemical loadings for remedial Alternative 5 were subsequently simulated from WF5.5 to the reservoir outlet. Alternative 5 was believed to best represent the anticipate chemical load for the Selected Remedy. Alternative 5 was assumed to have a 95 percent efficiency in chemical load reduction. The estimated remediation levels for the Selected Remedy are presented in the following table. The remediation levels are viewed as “goals” for the Selected Remedy due to the variability of acidity provided by the Alamosa River upstream of Wightman Fork and uncertainties of the model.

Parameter	***Remediation Levels at WF5.5 Required to Meet Water Quality Standards at Upstream Boundary of Alamosa River Segment 3c 1***	
	Low-Flow (ug/L)	***High-Flow (ug/L)***
Aluminum (total)	5,000	5,000
Cadmium (total)	2	14
Copper (total)	35 to 400 **2**	1,550
Iron (total)	25,000	55,000
Manganese (total)	15,000	22,000
Zinc (total)	2,800	2,450
Minimum pH (s.u.) **3**	6.6	5.1

Notes:

1. Remediation levels are estimated for times when the Water Treatment Plant is operating and discharging effluent to Wightman Fork (typically mid-May through October). Remediation levels apply to WF5.5, or a point sufficiently downstream of the new Water Treatment Plant discharge, the location of which will be determined during the Remedial Design phase. Remediation levels are based on model predictions when the Alamosa River upstream of Wightman Fork has a low-flow pH of 4.8 and a high-flow pH of 6.9.
2. The model predicts that if the pH of the Alamosa River upstream of Wightman Fork is between 5 and 6 during low flow, which is about one unit higher than the value used to estimate the 35 ug/L remediation level for copper, then the copper remediation level could be in the range of 200 to 400 ug/L. This higher range of remediation levels for copper should be achievable during the majority of the operational year.
3. Minimum pH values could be lower depending on the pH of the Alamosa River upstream of Wightman Fork.

The form of copper (particulate versus dissolved) is extremely sensitive to pH. Figure 7-3 illustrates the distribution of dissolved and adsorbed (particulate) copper as a function of pH in the upper portion of Segment 3c. The copper standard in Segment 3c is for dissolved copper. During low-flow periods, the pH of water in the Alamosa River upstream of Wightman Fork is strongly acidic (pH 4 to 5). Consequently, particulate copper entering the Alamosa River from Wightman Fork converts from the particulate to the dissolved form. When higher pH' s are present in the Alamosa River, much greater concentrations of copper can be released from the site because the copper remains in the particulate form upon entering the Alamosa River.

Predicted concentrations in the Alamosa River were sensitive to metal loadings but also to pH, iron concentration and residual sediment metal concentrations. The most difficult parameter, with respect to restoration of water quality within the river basin and the attainment of water quality standards, was copper during the low flow periods. Model predictions and dissolved copper concentrations in the Alamosa River are very sensitive to pH, particularly with respect to the contributions of acidity and metal from the Alamosa River above Wightman Fork. Under Alternative 5, the model predicted that water quality would be acceptable for all parameters except dissolved copper during certain low-flow conditions, but the copper standard would only be exceeded in the upper portion of Segment 3c. Terrace Reservoir would meet water quality standards for pH, aluminum, copper, zinc, iron and cadmium. The modeling also determined that pHs attained within the reservoir would keep metals bound to the sediments and would not permit significant release to the overlying water during either low-flow and high-flow.

The model predictions are directly related to underlying assumptions, which results in some level of uncertainty. The most important limitation of the model that should be taken into consideration is that the model was calibrated to two points in time, one representing low-flow conditions and the other for high- flow conditions. The hydrodynamics of the Alamosa River and Terrace Reservoir system at these two times is unique, but the hydrodynamics were assumed to be representative of future low and high-flow conditions for prediction purposes. As a consequence, metal transformations and subsequent transport and fate of metals under the two hydrodynamic flow regimes may not accurately predict future water quality conditions. Although model predictions have some level of uncertainty, the U. S. EPA and the State believe that the model provides the best available information from which remediation levels for the Selected Remedy can be estimated.

Remediation levels for the site will be revised, as necessary, based on continued data collection and monitoring of the Selected Remedy. Any revision, if necessary, will be discussed at the five-year review required by CERCLA 40 CFR Part 3000.430 (f)(4)(ii).

7.4.2 Expected On-Site Uses

After the Selected Remedy is implemented, the future uses of the site are not expected to change significantly. The site is currently restricted to authorized personnel and will remain so in the future, due to potential hazards that may remain in place. Land use at the site is not expected to change.

Surface water at the site in Wightman Fork and Cropsy Creek is not currently used for human consumption or operational purposes. The use of surface water is expected to remain the same after the Selected Remedy is implemented. Site groundwater is not used for human consumption. However, groundwater is used to supply the site with non-potable water for site operations. Future use of site groundwater is not expected to change from current conditions.

Environmental and ecological benefits will be realized at the site as OU4 reclamation matures. The maturation of vegetation on reclaimed slopes will provide habitat for indigenous species of animals. In time, the site' s landscape should return to that of a high- alpine ecosystem. However, due to the continued existence of acid mine drainage at the site, it is not expected that aquatic life will survive in site surface waters.

7.4.3 Expected Offsite Uses

Land downstream of the site to Terrace Reservoir is within the National Forest. It is in an undisturbed state and is characterized by diverse terrain and vegetation typical of the south- central Colorado Rocky Mountains. The area supports snowmobiling, cross country skiing, hiking, camping, horseback riding, hunting, livestock grazing, and other recreational activities. These land uses have occurred for decades and they are not expected to change in the future after the Selected Remedy is implemented.

The land downstream of Terrace Reservoir is largely privately owned and has been used for agricultural purposes since the mid-1800's. This land use is not expected to change. Small towns are among the irrigated land. Residents of the San Luis Valley living downstream of Terrace Reservoir within approximately 25 miles of the site, constitute the closest downstream population affected by the Summitville Mine. The affected population is not expected to change significantly in the near future.

Some socio-economic benefit may be realized in the future, with increased recreational use of the Alamosa River below the Town of Jasper. Achievement of water quality ARARs in Segment 3c of the Alamosa River and Terrace Reservoir may create conditions favorable for survival of aquatic life. These waters could potentially be used for recreational fishing, which could benefit the Jasper community.

The primary use of downstream surface water is for irrigation of croplands in the San Luis Valley. A similar use of surface water is expected to continue in the future after the Selected Remedy is in place. Groundwater downstream of the site is used for drinking water. Domestic wells have not been impacted by mine contaminants, as most of the wells are outside of the alluvial floodplain of the Alamosa River. Future use of groundwater downstream of the site is expected to remain the same.

The most notable change expected to result from the Selected Remedy is an improvement to the ecosystem downstream of the site. In particular, attainment of water quality standards in Segment 3c of the Alamosa River and downstream may result in a restoration of aquatic life. Re-establishment of the indigenous macroinvertebrate population upon which fish prey, should result in a sustained fishery capable of over winter survival.

8.0 STATUTORY DETERMINATIONS

This section of the Record of Decision provides a description of how the Selected Remedy satisfies the statutory requirements of CERCLA § 121, as required by NCP § 300.430 (f)(5)(ii), and explains the five-year review requirement for the Selected Remedy.

8.1 Protection of Human Health and the Environment

As reported in Baseline Human Health Risk Assessment (Morrison Knudsen Corporation, ICF Kaiser Engineers, Inc., 1995a) and the Public health Assessment (ATSDR, 1997), releases of contaminants from the site have not posed an unacceptable risk to human health. Risks were either below health advisories or below benchmarks, below the U. S. EPA's acceptable risk range of 10-4 to 10-6 for carcinogens, or non-carcinogenic risks were below a HI of 1.0. These determinations were based on water quality data collected in 1994 and 1995, which were years before many of the interim remedial actions at the site were complete. Considerable improvement in water quality has been evident in the Alamosa River and Terrace Reservoir since that time (Rocky Mountain Consultants, Inc., 2001c). Therefore, the combination of an impoundment and active water treatment as proposed in the Selected Remedy would continue to be protective of human health.

In terms of environmental protection, the Selected Remedy minimizes risks to downstream ecological receptors. The Tier 2 Ecological Risk Assessment (CDM Federal Programs, 2000) found that the aquatic life, primarily trout and macroinvertebrates, downstream of the site were severely impaired. The primary risk driver was copper, most of which comes from the Summitville Mine site. Reactive transport modeling of the Alamosa River estimates that if the remediation levels specified in Section 7.4.1 can be attained at the site, water quality ARARs should be achievable in Alamosa River Segment 3c and downstream. To that end, the Selected Remedy incorporates impoundment of contaminated drainage from the site and proven, active water treatment that has a high long-term reliability. These measures, together with a maturation of reclamation and other engineering controls at the site, will reduce the amount of acid mine drainage entering Wightman Fork and ultimately the Alamosa River.

8.2 Compliance with Applicable or Relevant and Appropriate Requirements

The Federal and State requirements, that are applicable, relevant and appropriate, or To Be Considered for the Selected Remedy are presented in Tables 4-1, 4-2, and 4-3 for chemical- , action- , and location-specific categories of ARARs, respectively. All action- and location- specific ARARs will be met by the Selected Remedy. All Chemical specific ARARs will be met, except for the agricultural use designation for Segment 6 and the numeric water quality standards and use classifications for Alamosa River Segment 3b, as discussed in the following section.

8.2.1 Waiver of ARARs

Implementation of the Selected Remedy will require waiver of certain water quality ARARs. Waiver of ARARs is permissible under CERCLA in certain limited circumstances. These are described in CERCLA § 121(d)(4), one of which is technical impracticability (see CERCLA § 121((d)(4)(C)). Technical impracticability is the justification to waive certain State of Colorado numeric standards and the use classifications for Alamosa River Segment 3b (mouth of Wightman Fork to Town of Jasper) and Segment 6 (Wightman Fork). These segments are shown on Figure 1-1. The specific requirements being waived are contained in Classifications and Numeric Standards for Rio Grande Basin, 5 CCR 1002-36. The technical impracticability of meeting these standards for each stream segment is discussed in greater detail below.

8.2.1.1 Alamosa River Segment 6

The agricultural use classification for Segment 6 (Figure 1-1) will be waived pursuant to

CERCLA § 121(d)(4)(C), technical impracticability. Although numeric standards for Segment 6 are not specifically stated in the regulations, they are implied by the agricultural use classification. The basis for this waiver is that naturally occurring drainage upstream of the site contains manganese concentrations that will prevent meeting the current agricultural manganese standard in Segment 6. The manganese agricultural standard for the Rio Grande Basin is currently 200 ug/L (5 CCR 1002-36). Review of water quality data from upper Cropsy Creek and upper Wightman Fork, areas that are upstream of the site and not impacted by recent mining activities, shows that these areas contribute sufficient manganese to exceed the agricultural standard for manganese. The source of the manganese is primarily acid rock drainage from mineralized terrains that ultimately flows into Segment 6. The surface water entering the site from the upper Wightman Fork drainage basin (WF1.5) and the upper Cropsy Creek drainage basin (Figure 2-3) contribute manganese loading to Wightman Fork unrelated to recent mining activities. Using the flow measured at station WF5.5, the manganese concentration was back-calculated to determine what it would be if the only sources of manganese were from the upper Wightman Fork and Cropsy Creek watersheds. Results of this analysis are presented in following table.

Sampling Event	***Wightman Fork Background Manganese Concentration* (ug/L)***
05-Jun-00	710
12-Jun-00	**1,190**
19-Jun-00	90
26-Jun-00	**230**
03-Jul-00	140
10-Jul-00	**440**
17-Jul-00	70
24-Jul-00	**210**
31-Jul-00	80
07-Aug-00	60
14-Aug-00	**1,330**
21-Aug-00	120
28-Aug-00	130
04-Sep-00	140
14-Sep-00	**410**
18-Sep-00	**280**
25-Sep-00	**760**
02-Oct-00	120
09-Oct-00	410
16-Oct-00	110

* Indicates that this manganese concentration is based on WF-1.5 and CC-1.
Bold underline values exceed the State of Colorado surface water agricultural standard of 200 ug/L (WQCC Regulation No. 31)

The manganese from these areas would have caused the agricultural standard to be exceeded in one-half of the monitoring events during 2000. Remediation or engineering controls at the site will be incapable overcoming this condition. Therefore, a technical impracticability waiver of the agricultural use classification for Segment 6 is justified.

8.2.1.2 Alamosa River Segment 3b

The justification for invoking a use classification waiver for Segment 3b (Figure 1-1) is the analysis performed in the Use Attainability Assessment (Posey and Woodling, 1998). The goal of this work was to determine if pre-mining water quality could attain the assigned water quality standards. The Use Attainability Assessment demonstrated that the currently assigned aquatic life use classification of Class 1 - Cold Water for Segment 3b is unattainable due to the presence of naturally occurring mineralized terrains upstream of Wightman Fork that contribute metals and acidity to the Alamosa River. Therefore, waiver of certain numeric water quality standards for Segment 3b, cited in Classifications and Numeric Standards for Rio Grande Basin (CCR 1002-36) will be necessary.

The Use Attainability Assessment demonstrated that considerable acidity, aluminum and iron loading originates in the Alamosa River basin upstream of Wightman Fork. The source of the acidity and metals is drainage from naturally occurring, mineralized terrains in the Iron, Alum, and Bitter Creek drainages. The naturally occurring sources pre-date mining in the area and have resulted in impaired background conditions. Recent sampling of both water quality and aquatic life in the Alamosa River has confirmed that sources upstream of Wightman Fork are the primary contributors of aluminum, iron, and acid to the mainstem of the Alamosa River (Rocky Mountain Consultants, Inc. 2001c). Since restoration of the Alamosa River could not be better than the background or baseline condition, Segment 3b numeric standards for aluminum, iron, and pH will be waived. It is the intent that copper and other metal standards, not specifically waived at this time, will be met.

The table below summarizes the historic concentrations (November 1986 through May 2001) for dissolved aluminum, total recoverable iron, and pH measured at surface water monitoring station AR45.5. This monitoring station is at the downstream end of Segment 3a and provides a measure of aluminum, iron, and acidity from areas upstream of Wightman Fork that negatively impacts Segment 3b. The table shows the number of times the particular analyte was tested; average, minimum and maximum concentrations; and the percentage of time the water quality standard for Segment 3a was exceeded.

	pH ***Seasonal Standards:*** ***12/1 - 2/28 = 3.53 - 9.0*** ***3/1 - 5/31 = 4.0 - 9.0*** ***6/1 - 8/31 = 4.73 - 9.0*** ***9/1 - 11/31 = 3.94 - 9.0***	***Dissolved Aluminum Acute Standard = 750 ug/L***	***Total Recoverable Iron Chronic Standard = 12,000 ug/L***
Number of Times Analyzed	116	91	115
Minimum Concentration (ug/L)	3.40	10	50
Maximum Concentration (ug/L)	7.10	8,070	180,030
Average Concentration (ug/L)	5.4	1,390	10,440
Percentage of time that Standard has been Exceeded	18%	37%	20%

The Alamosa River upstream of Wightman Fork is naturally acidic as evidenced by the minimum pH value of 3.4 and average pH of 5.4. The average dissolved aluminum concentration over the historic period was 1,390 ug/L, which is almost twice as great as the acute standard of 750 ug/L. The aluminum standard was exceed 37 percent of the time samples were collected. The chronic standard for total recoverable iron was exceeded 20 percent of the time, with an average concentration (10,440 ug/L) near the chronic standard (12,000 ug/L).

The basis for waiver of use classification Class 1 - Cold Water Aquatic Life and the aluminum, iron, and pH numeric standards for Segment 3b is CERCLA § 121((d)(4)(C), technical impracticability. Remediation or engineering controls at the site will be incapable of achieving the aquatic life use classification and water quality standards for aluminum, iron, and pH in Segment 3b as a result of naturally occurring background conditions in Segment 3a that impact Segment 3b. Remediation at the site cannot eradicate or overcome this condition. Therefore, a technical impracticability waiver in accordance with 40 CFR § 300.430(f)(1)(ii)(c)(3) is justified.

8.2.2 Total Maximum Daily Loads

The Clean Water Act Section 303(d) requires states to identify water bodies that are not attaining their designated uses or assigned water quality standards, which is referred to as the 303(d) List. The Water Quality Control Division (CDPHE) administers the Clean Water Act in Colorado, and is responsible for developing the 303(d) List based upon credible water quality data. States, as specified by the Clean Water Act, update their 303(d) List every two years based upon new information concerning all of the state’s water bodies. Due to proposed changes in the regulation governing the methodology of developing the 303(d) List, U. S. EPA withdrew this requirement for the 2000 reporting cycle. Thus, Colorado’s current 303(d) List was last updated in 1998. The next updated 303(d) List is expected to be presented to the U. S. EPA for approval on October 1, 2002 (U. S. EPA proposed date).

Section 303(d) of the Clean Water Act also requires states to determine and assign a Total Maximum Daily Load (TMDL) for each pollutant in a water quality limited water body, i.e. a water body identified on the 303(d) List. A TMDL quantifies the amount of a specific pollutant that a water quality limited water body can assimilate without violating the applicable water quality standard and to apportion that pollutant quantity among the known sources, which includes point sources, non-point sources, and background or unknown pollution. In order for a TMDL to be achieved for a water quality limited water body, point sources and anthropogenic non-point sources must be managed or mitigated in a manner to attain the water quality standard for the TMDL pollutant throughout the water body. Amelioration of background pollution may also be considered in a TMDL if it is necessary.

The 1998 Colorado 303(d) List identified four water quality limited water bodies, (i.e. water bodies that are not attaining their designated uses or assigned water quality standards), in the Alamosa River Basin that are hydrologically connected to the Summitville Mine site. The four water bodies and pollutants requiring a TMDL are listed below.

State Water Body Identification	*Description*	*Segment*	*Pollutants Requiring TMDL*
CORGAL03B	Alamosa River - Wightman Fork to Terrace Reservoir	3b and 3c	pH, aluminum, copper, and iron
CORGAL08	Terrace Reservoir	8	pH, copper, manganese, and zinc
CORGAL09	Alamosa River - Terrace Reservoir to Colorado Highway 15	9	pH, copper, iron, manganese, and zinc
CORGAL10	Alamosa River - Below Colorado Highway 15	10	copper, manganese, and iron

Development of TMDLs for all the 303(d) List pollutants in each water body is expected by June 30, 2004. Because the TMDLs for the four water bodies listed above have not been promulgated, they are not enforceable and are not ARARs for the final remedial action. The TMDLs, at the discretion of U. S. EPA and CDPHE, may become To Be Considered ARARs upon promulgation.

8.3 Cost Effectiveness

A cost-effective remedy as defined by the NCP is one whose “costs are proportional to its overall effectiveness.” The overall effectiveness of the Selected Remedy is determined by evaluating the criteria long-term effectiveness and permanence, reduction in toxicity, mobility, and volume through treatment, and short-term effectiveness. The overall effectiveness is then compared to cost to determine whether a remedy is cost-effective. The table below provides a cost effectiveness evaluation where remedial alternatives are compared to the Selected Remedy (combination of Alternatives 4 and 5).

Alternative	***Present Value***	***Incremental Cost Increase (+) or decrease (-)***	***Long-Term Effectiveness and Permanence***	***Reduction of Toxicity, Mobility, or Volume***	***Short-Term Effectiveness***
1A - No Action	$9,696,000	-----	Low	Low	Low
1B - No Further Action/SDI Breach	$16,637,000	+ $ 6,941,000	Low	Low	Low
2- Clean Water Diversion/New Dam Below Confluence of Wightman Fork and Cropsy Creek/ Passive Water Treatment	$35,534,000	+ $ 18,897,000	Unproven passive treatment technology	Low to moderate reductions	Low due to considerable construction disturbance in Wightman Fork
3 - Upgrade SDI/Existing Water Treatment Facility with Seasonal Treatment	$85,423,000	+ $ 49,889,000	Low due to frequent releases of untreated water	Moderate reductions from impoundment and treatment	Moderate, no disturbances but will still have frequent releases
4/5 - Upgrade SDI or New Impoundment/New On-site Water Treatment Plant with Flexible Treatment Season	$71,787,000 to $74,258,000	- $ 11,165,000 to - $ 13,636,000	High due to permanent storage impoundment and proven treatment system	Highest due to impoundment and treatment	Moderate because some construction disturbance will occur in Wightman Fork

The cost-effectiveness evaluation shows that Alternative 3 is the least cost-effective because it has the highest costs and is only low to moderate in the three criteria categories. Alternative 2 is slightly more cost-effective because it has an overall lower total cost, but relies on an unproven passive water treatment technology. Alternatives lA and 1B have low overall costs, but are unacceptable because they provide little short-or long-term effectiveness or reduction of contaminations. The Selected Remedy (combination of Alternatives 4 and 5) provides the highest long-term effectiveness and highest reduction in toxicity, mobility, and volume of site contaminants among the remedial alternatives that were evaluated. Its short-term effectiveness is considered to be moderate. The Selected Remedy is therefore judged to be cost-effective.

8.4 Utilization of Permanent Solutions and Alternative Treatment Technologies

The NCP emphasizes the factors of long-term effectiveness and reduction of toxicity, mobility, and volume through permanent solutions. The Selected Remedy addresses this by incorporating a permanent water storage and treatment system. The water treatment technology considered in the Selected Remedy consists of either lime or sodium hydroxide for pH adjustment and polymers for thickening and precipitation of metals. This type of conventional water treatment is commonly used at mine sites in the Rocky Mountain region with a high degree of success and reliability.

Alternative (passive) treatment technologies such as Successive Alkalinity-Producing Systems, Aquifix System, and Zeolite Systems have been tested at the site. Although preliminary results of the passive treatment technologies indicate relatively high removal rates for some metals, their ability to treat the large volume of acid mine drainage generated at the site is unproven. Passive treatment technologies, and potentially other alternatives treatment technologies, will continue to be evaluated with respect to changing site conditions.

8.5 Preference for Treatment as a Principal Element

The statutory preference for treatment as the principal element is satisfied by the Selected Remedy. The water treatment addresses the principal threat waste (i.e., acid mine drainage). The combination of impoundment of contaminated water and active water treatment are the key components of the Selected Remedy, and provide the highest level of contaminant reduction and long-term effectiveness.

8.6 Five-Year Review Requirements

The purpose of this section is to explain determinations for five-year reviews. The NCP (§ 300.430(f)(4)(ii)) requires a statutory five-year review of remedial actions that result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. At the time of the review, the remedy will be evaluated if it is currently, or will be, protective of human health and the environment. Because acid mine drainage will remain at the site, the Selected Remedy will be subjected to a five-year review.

8.7 Documentation of Significant Changes

The Proposed Plan for the Summitville Mine site was released for public comment in June 2001. The Proposed Plan identified a combination of Alternatives 4 and 5 as the preferred remedial alternative. This combination includes either upgrading the existing SDI or construction of a new dam and impoundment, construction of a new water treatment plant downstream of the on- site impoundment, with a flexible water treatment season. All written and verbal comments submitted during the public comment period were reviewed. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

However, three changes to the preferred alternative identified in the Proposed Plan have been made. The changes and rationale for making the changes are described in the following.

1. Chandler Adit Rehabilitation - The preferred alternative in the Proposed Plan included rehabilitation of the Chandler Adit to make it machine-accessible, and properly drained and supported. However, the Selected Remedy in this Record of Decision includes management of the mine pool. Management of the mine pool will be such that the mine pool will be lowered to an elevation below the Chandler Adit. Lowering of the mine pool will reduce the generation of acid mine drainage and will reduce non-point seepage primarily in the Chandler Groin area. Because U. S. EPA and the State are committed to managing the mine pool, rehabilitation of the Chandler Adit is no longer necessary and it is not a component of the Selected Remedy.

2. Building Demolition - The preferred alternative in the Proposed Plan included demolition of non-essential buildings at the site. Since issuance of the Proposed Plan, U. S. EPA and the State have determined that demolition of site buildings is not necessary to protect human health or the environment. Therefore, the Selected Remedy does not include building demolition.

3. Rockwall Fence - The preferred alternative in the Proposed Plan included construction of a rockwall fence. The purpose of the fence was to protect the ditch at the base of the Highwall from erosion of the Highwall and to prevent accumulation of rocks on the surface of the mine pits. The U. S. EPA and the State believe that the rockwall fence is not necessary. Instead, accumulation of rock in the ditch at the base of the Highwall and on the surface of the mine pits will be addressed through site maintenance.

The U. S. EPA and the State believe that these changes are not significant to the overall remedy at the site. The changes do not affect the storage, conveyance, or treatment of contaminated water, which are the primary components of the Selected Remedy.

9.0 RESPONSIVENESS SUMMARY

This section of the Record of Decision contains a Responsiveness Summary, which presents the comments made by the public regarding both the remedial alternatives and its concerns about the site. These comments were made by the public at two public meetings or were submitted in written form during the extended (60-day) public comment period. The Responsiveness Summary, also documents, in the Administrative Record, how public comments were integrated into the decision-making process. This Responsiveness Summary was developed in accordance with the U. S. EPA guidance document "Community Relations in Superfund: A Handbook." ((EPA 540-R-92-009, January 1992).

In June 2001, U. S EPA issued a Proposed Plan, which identified U. S. EPA and the State s preferred alternative for the final remedy to be implemented at the site. Although U. S. EPA and the State have solicited the public's input throughout the Remedial Investigation/ Feasibility Study process through a series of "stakeholder" and public meetings, the agencies specifically have addressed three overriding concerns of the public in this Record of Decision and Responsiveness Summary. Specifically, the agencies have addressed previously uncontrolled or untreated releases of contaminated water and management of the mine pool by increasing the design capacity of the on-site impoundment. The agencies have also provided additional information on and a commitment to re-evaluate the need to remediate sediments in the Alamosa River and Terrace Reservoir.

All comments received by CDPHE and U. S. EPA prior to the end of the public comment period are documented and addressed in the following Responsiveness Summary. Comments received were in the form of letters from community members or verbal comments made at the Public Meeting. The following summarizes comments and responses placed into these categories:

- Preferred Alternative
- Water Treatment/Sludge
- Impoundment
- Mine Pool
- Heap Leach Pad
- Water Quality/Sediments
- ARARs
- Site Maintenance
- General

Preferred Alternative

Comment: *As president of the Jasper Association I think I can speak for all the property owners in that we are concerned with the remedial action to be taken at this contamination site. In reviewing the alternatives I would choose number 5. It requires the greater capital cost but will give us the bigger bang for our buck in the long run. It holds the greatest positive comparison criteria and has the overall highest remedial effect.* - Mr. Alan Hulen

Response: The preferred alternative chosen by the agencies is a combination of Alternatives 4 and 5. The agencies likewise believe this alternative provides the greatest level of protection of human health and the environment in the most cost- effective manner.

Comment: *We could support alternative 5 in the April 2001 Draft Feasibility Study if: one, the design ensured that there would be no untreated releases into the Alamosa River or its tributaries; two, the design recognize that reclamation would not be 100 percent effective and allow the diversion of water into the impoundment; three, no ARARs are waived in the final remedy and all water quality standards are met at all times; and four, alternative sediment remediation, component for all segments that would ensure that the goal of restoring a viable fishery will be met in a reasonable amount of time.* - Ms. Cindy Medina on behalf of the Alamosa River Keepers

Response: The U. S. EPA and the State believe that sizing of the impoundment to contain the design event (100-year snow melt and 500-year precipitation event) and construction of a new, reliable water treatment plant that has a flexible treatment season assures that releases of untreated water from the on-site impoundment will be eliminated. The Selected Remedy will allow for collection and treatment of acid mine drainage from areas where reclamation is not 100 percent successful. The Selected Remedy, however, will require waiver of select water quality standards in Segment 3b as discussed in Section 8.2.1. These waivers are justified due to water quality impacts from areas upstream, which are not related to the Summitville Mine Superfund site. Sediment remediation along the Alamosa River is not included in the Selected Remedy. Based on monitoring data and computer modeling, the agencies believe that Remedial Action Goals can be achieved without sediment remediation. To the extent that sediments prevent attainment of Remedial Action Goals, remediation of sediments may be evaluated at the five-year review of the Selected Remedy.

Comment: *In your letter of June 8, 2001, you state that EPA and CDPH&E "will make a final selection from one of the alternatives listed in the plan." We have previously advised that the only alternative worthy of consideration is # 5, but to restrict action to only that which is included in it has been apparently reconsidered - for good reason. That is good news. This year, again, there has been untreated water released from the site into Wightman Fork. From our perspective, this is the issue with the highest priority. The final remedy proposes a larger dam impoundment and a more efficient treatment plant with a higher treatment capacity and with the flexible option of operating for longer periods. Flexibility will allow for water treatment to occur according to need and be less vulnerable to the capriciousness of the weather. We therefore enthusiastically endorse this portion of the plan.* - Mr. Ignacio Rodriguez, Summitville Technical Assistance Group

Response: The reconsideration that is mentioned in this comment refers to the combination of Alternatives 4 and 5 as the Selected Remedy. The agencies appreciate the TAG's comment.

Comment: *We hear that the final remedy was considered too specific in some official quarters. We think it was not specific enough and that there were significant gaps. We would appreciate your noting our concerns in any reports that you prepare addressing this issue.* - Mr. Ignacio Rodriguez, Summitville Technical Assistance Group

Response: Agency review of the proposed remedial alternatives in the Feasibility Study found little difference between Alternatives 4 and 5, in terms of overall cost, protection of human health and the environment and in meeting the other NCP criterion. However, the two alternatives were based on varying degrees of reclamation success. Because some reclamation continues at the site and the true success of reclamation will not be known for some time, the agencies believe that a more general Selected Remedy was appropriate, pending the demonstrated outcome of reclamation. The generality was related to the size of the on-site impoundment and the exact location of the new, gravity-fed water treatment plant. To be specific about impoundment size and WTP location at this point, could prove detrimental especially if additional data shows the size of the impoundment or location of the WTP need to be altered. Additional data collected through 2003 would be used to support remedial designs.

Comment: *The final remedy as presented sounded very much like Alternative # 5 as originally drafted in the Engineering Alternatives document. This option includes increased storage capacity and active water treatment utilizing gravity flow delivery on untreated water to the treatment plant. This alternative includes a new dam built just downstream from the existing SDI embankment, which will be breached when the new dam is operational. This is the only alternative that has a lick of chance on attaining the # 1 priority goal of an acceptable* final remedy: ELIMINATION OF RELEASE OF UNTREATED WATER FROM THE SUMMITVILLE MINE SITE. - Mr. Ken Kclo Summitville Technical Assistance Group

Response: The agencies agree that eliminating untreated releases from the impoundment is one of the primary goals of the Selected Remedy. The Selected Remedy will be the most protective of human health and the environment and will be the most ARAR compliant of the remedial alternatives that were evaluated.

Comment: *The Rio Grande National Forest (Forest) would like to comment on the Proposed Plan for the Summitville Mine Superfund Site. Forest staff and managers believe that Alternative 5 - New Dam Upstream of Wightman Fork-Cropsy Creek Confluence/new Gravity-Fed Water Treatment Plant with Flexible Treatment Season - offers the best overall protection of human health and the natural resources within the Rio Grande National Forest.*

The Preferred Alternative is too general and non-specific for the Forest to support its implementation. We need to know the exact location and size of the on-site impoundment of contaminated waters and water treatment plant in order to assess their impact(s) on the Forest. This information is critical if the on- site impoundment and water treatment plant will be located on public lands administered by the Forest Service. Selecting an alternative and then addressing the specifics at a later date does not follow established Forest planning procedures nor comply with the national Environmental Policy Act (NEPA) process. - Peter L. Clark, United States Department of Agriculture

Response: The exact location of the impoundment will be decided during the Remedial Design phase. At present, if a new dam were built it would be downstream of the existing dam of the SDI and upstream of the confluence of Wightman Fork and Cropsy Creek. This area is within the Summitville Mine Superfund permit boundary and not on U. S. Forest land. The new water treatment plant would be located further downstream, at a lower elevation to provide for use of a gravity-fed influent delivery system to the water treatment plant. Two locations for the new water treatment plant have been preliminarily identified. The current preferred location near the Wightman Fork and Cropsy Creek confluence at an elevation of approximately 11,115 feet. Most all of this area is within the Summitville Mine superfund permit boundary. Some portions of the treatment plant, such as an access road to the plant or support buildings, might extend onto U. S. Forest lands. The extent to which this is necessary would be identified during the Remedial Design phase and the Rio Grande National Forest would be notified. A second possible location of the new water treatment plant would be further downstream at an elevation of approximately 11,080 feet. This location is within the Spar Placer MS No. 5736 claim boundary and not on U. S. Forest lands. Again, it may be necessary to construct an access road to the plant through U. S. Forest land and the Rio Grande National Forest would be notified if such a requirement is later identified.

Water Treatment/Sludge

Comment: *A water treatment facility at (or near Summitville) which requires daily (monthly) maintenance is a bad idea.* - Mr. Walter L. Baker

Response: Active water treatment at the site has been responsible for significantly reducing the principal threat (acid mine drainage) at the site. Furthermore, water treatment at the site is responsible for much of the water quality improvement measured in the Alamosa River and Terrace Reservoir in the past several years (see Section 2.9.2). Although this type of treatment at the site incurs operation and maintenance costs, the agencies believe that these costs are justified and necessary to minimize risks to the environment downstream of the site.

Comment: *So with this new treatment plant, can you treat maybe twice as much water?* - Mr. Jim Snook

Response: The preliminary design of the new water treatment plant is 1,000 gpm, which is the same treatment rate as the existing water treatment plant. However, the new water treatment plant would have a gravity-fed influent delivery system that would allow the plant to operate year-round, if needed. Also, the influent delivery system would be able to access the entire storage of the impoundment, whereas the current system has a relatively large “dead pool” that cannot be accessed. With the extended treatment season and efficient delivery system, more contaminated water can be treated on an annual basis. Thus, the system is able to treat more water, but whether it can treat twice as much water is not known at this time.

Comment: *What do you do with the residue that comes out of the treatment?* - Mr. Jim Snook

Response: Currently, the residue (filter cake or sludge) is dewatered and transported to a disposal area at the South Pit. For the Selected Remedy, a new, engineered sludge repository would be constructed at the North Pit. The specifications for the sludge repository are contained in Appendix C, Figure C. 5 of the Feasibility Study Report.

Comment: - *Does that pit (South Pit) have a pad under it so that it doesn’t contaminate the ground water?* - Mr. Jim Snook

Response: The former South Pit is lined with compacted clay followed by a layer of lime kiln dust for neutralization of acidic water. The bottom liner does not prevent groundwater movement into or out of the former South Pit.

Comment: *Active water treatment and adequate storage of polluted water are of utmost importance. We hope that a final remedy will be instituted soon. If it takes another season to realize that if we have snow pack, we do not have adequate storage, we do not have adequate water treatment; then we need to move from there. The sooner the better.* - Mr. Ken Kclo Summitville Technical Assistance Group

Response: - The agencies agree that storage and treatment of contaminated water is of primary concern at the site. Before the final remedy is implemented, a Remedial Design will be necessary. Additional data collected through 2003 would be used to support remedial designs. The agencies are hopeful that the final remedy can be implemented in a timely manner after the Remedial Design phase is complete.

Comment: *It’s obvious to me that we need no more release. I think it comes from a lot of the community members, no more releases is really, really important and the data shows that even effective water treatment is not very effective. So let’s fix the defects and get it extremely effective.* - Ms. Maya ter Kuile

Response: The agencies are committed to eliminating releases of untreated water from the site through appropriately sizing the on-site impoundment and construction of a new, reliable water treatment plant that, if needed, could operate year-round. The Selected Remedy incorporates all of these components.

Comment: *Efficient, cost-effective active water treatment with a storage system to facilitate maximum water treatment plant operation is critical. The plant must be flexible enough to operate more than six months per year, maybe eight or ten months in a wet year. At a minimum, the plant must be able to handle normal snow pack years without being overtaxed, resulting in untreated release of water from the SDI, as is the case for this season and four of the past six years.* - Mr. Ken Kclo Summitville Technical Assistance Group

Response: The Selected Remedy will meet these criterion.

Impoundment

Comment: *I fully agree. The best way to treat the Summitville/Alamosa water is by the damming of the flow and then allowing chemistry and Mother Nature to work their magic. For nearly the past ½ century, I have been amazed in the difference of water quality in that flowing into and out of Terrace Reservoir. It is evident flocculation, oxidation, reduction, or some other unknown biologic process occurs in these waters when they are* *allowed to stand stagnant (still) for a few hours (days). Please carefully consider the viability of placing a dam across the Alamosa River. The location of the dam should be one mile down stream of Wightman Fork. Along this route, the road is well above the river level, so large amounts of money would not need to be spent re-locating the road. A dam/ lake placed at this location would not only treat the Summitville water, but would also allow the settling of the waters from Iron, Alum and Bitter Creeks. A dam at Wightman Fork is a good idea. A dam - JUST BELOW Wightman Fork is a much better idea. A dam placed below Wightman Fork, the Summitville issue will be addressed and a sustainable fishery in the Alamosa River down to and including Terrace Reservoir is possible*. - Mr. Walter L. Baker

Response: A dam located on the Alamosa River downstream of Wightman Fork was evaluated in the preliminary screening of remedial alternatives. Information regarding that evaluation is contained in the Engineering Alternatives Report (Rocky Mountain Consultants, Inc. 2001a). Briefly, a new dam on the Alamosa River was considered (Alternative 6a of the Report) near surface water monitoring location AR43.6, which is about two miles downstream of the Wightman Fork confluence. The dam would have created a 15,333 acre-foot reservoir impounding water approximately 1.7 miles upstream of the confluence of Wightman Fork. The new dam was judged to provide medium effectiveness in achieving water quality standards. Construction of the new dam would be difficult due to permitting and water rights issues. The total 30- year present value for the new dam was estimated to be $ 52,720,000, most of which was capital costs for construction. Due to the administrative difficulties in implementing this alternative and its high cost, it was not carried forward to the Feasibility Study.

Comment: *I think a goal of the final remedy, and hopefully it will be to eliminate untreated releases of polluted water from the site. Until we have that commitment, the final remedy will always be in a situation of where we have found ourselves this season, not quite enough storage, not quite enough treatment, and we have polluted water leaving the site.* - Mr. Ken Kclo Summitville Technical Assistance Group

Response: The Selected Remedy is committed to eliminating releases of contaminated water from the site. To this end, the most critical factor in eliminating untreated releases is the size of the on-site impoundment. The snowmelt runoff and success of OU4 reclamation drive the sizing of the impoundment. The agencies have deferred sizing of the impoundment to the Remedial Design phase. This will allow for additional data to be collected to estimate the success of reclamation and the magnitude of acid mine drainage that will remain after reclamation is complete.

Comment: *Goals will also not be met because the preferred alternative does not guarantee that untreated releases from the site will be eliminated. Any untreated releases will likely result in a fish kill*. - Ms. Cindy Medina on behalf of the Alamosa River Keepers

Response: The Selected Remedy will include an impoundment sized to contain the design event, which consists of the 100-year snowmelt and 500-year 24-hour precipitation. The new water treatment plant will be gravity-fed and will allow for treatment during the winter, if needed, which in turn, will enable the impoundment to be nearly empty at the beginning of the snow melt. Combined, these two elements of the Selected Remedy will attain remedial goals and will provide the highest probability of assuring that untreated water would not be released from the on-site impoundment.

Comment: *Reiterating my comment after the Spring 2000 meeting, and in agreement with the Technical Assistance Group member comments, I feel we need to eliminate spills of untreated Summitville water during peak runoff. I’m not confident that your treatment/ impoundment system in the preferred alternative will accomplish this, and I’m not even sure EPA & CDPHE is confident of it.* - Comment Card from Mr. Paul Sinder

Response: The agencies are confident that the Selected Remedy will accomplish the goal of eliminating untreated releases from the on-site impoundment. The commitment to accomplishing this goal is evidenced by deferring sizing of the on-site impoundment until the Remedial Design phase. By doing this, additional data can be collected, reclamation will be entirely complete, and the degree of long-term reclamation success will be better defined. This will allow for an appropriately sized impoundment to be designed.

Comment: *High altitude reservoirs should be built to make sure the treatment plant does have the correct amount of cfs to operate correctly. These reservoirs would also serve as a flood control feature on the Alamosa watershed. This is definitely needed as downstream users have often suffered loses during flood times.* - Mr. John B. Shawcroft

Response: High altitude reservoirs on Wightman Fork are not needed for the water treatment plant to operate. A single, appropriately sized impoundment is sufficient to assure that water is available for treatment. The new water treatment plant in the Selected Remedy will have a gravity-fed influent delivery system from the on-site impoundment. The influent delivery system will be able to access the entire stored water in the impoundment. High altitude dams on the Alamosa River upstream of Wightman Fork for flood control are beyond the scope and role of the Selected Remedy (OU5). Further, because these dams would be designed to prevent floods rather than to assist the remediation of site contaminants, Superfund monies cannot, by law, be used to build them.

Comment: *I feel that the present administration of the State is more receptive to reservoir building than has been the case in the past. This provides the opportunity we need to go forward, The Alamosa-La Jara Conservancy District is more than willing to assist in such a plan or similar plans*. - Mr. John B. Shawcroft

Response: Impoundment and active treatment of contaminated water from the site is the only proven and reliable means to control site contaminants from entering the downstream environment. Impoundment and active treatment reduces the toxicity, mobility, and volume of contamination and is protective of human health and the environment. It is for these reasons that the agencies support the Selected Remedy that includes an on-site impoundment.

Comment: This letter is sent to comment upon the draft RI/FS for the Summitville Mine Superfund Site. My recommendation is to upgrade the Summitville Dam Impoundment (SDI). I do not favor construction of a new dam downstream from the existing one for several reasons as follows - Virginia B. Norman

- *The site already has a dam, which could be modified for a fraction of the cost of building a new one.*

Response: The existing SDI could be raised to provide additional storage capacity. However, the cost to do so would not be a fraction of the cost to build a new one as the commenter states. The current SDI outlet works cannot access the majority of the stored water. This results in a large dead pool. If the existing SDI dam was raised, the majority of the dam would have to be excavated to position new outlet works at a lower elevation to access the entire stored water. Preliminary costs have been estimated to raise the existing SDI dam and the costs would be similar to the cost to construct a new dam.

- *New construction will result in a loss of more riparian and forest habitat for placement of the dam embankment, diversion channels, and the reservoir. Fixing the problems with the existing dam would have a minimal impact on habitat.*

Response: The preliminary location for a new dam would be 200 to 300 feet downstream of the existing SDI dam. The landscape in this area consists of rocky slopes and willows. A new dam in this area would result in a loss of approximately six acres of potentially habitable terrain.

- *A new, larger reservoir means more acid water and metals laden muck will be stored. My understanding is that the existing SDI embankment would be breached but no effort* *would be made to remove the acidic muck from the reservoir bottom. The project goals should be directed towards reducing and eventually eliminating the impacts to the Wightman Fork Creek riparian zone rather than expanding them.*

Response: The primary threat at the site is release of contaminated water from the on-site impoundment that adversely impacts the downstream ecosystem. The greatest overall benefit, in terms of protecting the ecosystem downstream of the site, would result from containing and treating contaminated water and eliminating releases of untreated water from the on-site impoundment. To accomplish this, an appropriately sized on-site impoundment and new water treatment system are necessary. Minimal expansion onto riparian land to accomplish these goals is judged to be acceptable and necessary for protection of the environment.

- *The harsh climate of Summitville does not favor the use of Roller Compacted Concrete, which is more porous than conventional concrete. Longevity and maintenance are significant concerns. How many RCC dams has Rocky Mountain Consultants built in similar cold and wet climates and what have they learned regarding the longevity of this material? How will the acid affect the RCC what other sites have had success in storing acid water using RCC?*

Response: The Feasibility Study identified three types of dams that could be constructed: roller compacted concrete (RCC), concrete-face rock fill, and earthen fill. For costing purposes, a RCC dam was used because this type of dam tends to be more expensive than the other two and costs for it provided an upper end on the range of possible costs to construct a dam. The primary concern with an RCC dam is how the acidic water will react with (and potentially breakdown) the concrete. Rocky Mountain Consultants, Inc. has constructed two RCC spillways, and has constructed concrete-faced rock fill and earthen fill dams in mountainous terrains. As stated in the Feasibility Study, the type of dam will be determined during the Remedial Design phase. During this phase, it is expected that testing of cement and site waters would be conducted for both RCC and concrete-faced rockfill dams, in addition to borrow investigations to determine if suitable earthen or rock materials are available on site for dam construction.

- *The harsh weather conditions at the site have affected almost every important structure installed by the mining company or the government. It has required time and experience to identify and work out problems, which have delayed construction schedules, increased costs, and affected the quality and function of the work. The new dam is likely to cost more than anticipated as unforeseen problems will arise. It will probably have acid seepage escaping from it just as the present one does. The problems with the existing dam are known and will be much more easily addressed than the unknowns yet to be discovered from installation a new dam.*

Response: The cost of building a new dam or modifying the existing SDI dam are similar. The estimated cost of a new dam was developed by CDPHE s contractor using its considerable experience with costing and supervising construction of dams. The contractor has engineered and constructed dams in mountainous terrains. Costs for a new dam at Summitville were adjusted to account for construction activities at high altitudes. The agencies are confident that the cost estimates are within the U. S. EPA guidance criteria.

Most dams are designed to seep or drain. Seepage is necessary to minimize the buildup of pore water pressure within the dam that could lead to slope instability. The current SDI was built with a “chimney drain” that issues water at the toe of the dam. This untreated water enters Wightman Fork and is a source of metals and acidity as identified during the Remedial Investigation. Alternatives 4 and 5 have both been designed with seepage collection systems (see Appendix C, Figure C-4 of the Feasibility Study). These systems are designed to collect seepage issuing from the dam and either pump it back to the impoundment or transmit it directly to the treatment plant. Seepage from the dam in the Selected Remedy will not flow untreated into Wightman Fork.

Comment: *Regarding the SDI, more effort should be expended on improving the structure. Upgrading the dam spillway to handle the 100-year storm would be a worthwhile investment.*
- Virginia B. Norman

Response: The existing SDI spillway is designed to only handle the 25-year storm event. Designing the spillway to handle the 100-year storm would be beneficial, only to the extent of reducing erosion along the spillway that could lead to potential failure of the dam. The Selected Remedy will include a dam with a spillway that could pass one-half the probable maximum precipitation. Which is considerably larger than a 100-year storm event.

Comment: *Other SDI improvements should include:* - Virginia B. Norman

- *Excavation of acid muck and Beaver Mud Dump landslide debris from the SDI to increase the reservoir storage volume.*

Response: Removal of contaminated sediment from the SDI would provide minimal additional storage volume. Such removal would require dredging or draining of the SDI to remove sediments, which would have severe negative impacts to the downstream water quality if water treatment were taken off-line. Most of the waste materials in the Beaver Mud Dump have been removed. The Beaver Mud Dump landside debris was removed in 2001 and the slopes were reclaimed. Little, if any, additional storage volume was gained by removal of these materials.

- *Diversion of the ditch A and S flows to the Wightman Fork Diversion ditch .*

Response: Ditches A and S convey some of the most contaminated waters at the site. The water in the ditches is conveyed to the SDI where it is eventually treated. These ditches receive drainage from the North Waste Dump, seepage from Chandler Adit Groin, and Missionary Seeps area. Water in these ditches, as measured at station SC-7, was responsible for the highest copper and zinc load in 1999 and 2000 (see Remedial Investigation Report Figures 4.2-13 and 4.2-14). Diversion of water in these ditches directly into Wightman Fork Diversion (a clean water diversion) would have a severe impact on the downstream water quality.

- *Since the North Waste Dump and Missionary Seeps areas are reclaimed, the surface flows should be routed to the Wightman Fork Diversion rather than continuing to collect this surface runoff. This would remove approximately 200 acres from the SDI watershed. Acid seeps (only a few major ones that are mining related) could be captured into drainage pipes that could be directed to the SDI for treatment.*

Response: Monitoring data from runoff and seepage at the North Waste Dump and Missionary Seeps area shows that the water has high concentrations of metals and low pH. The contaminated water is currently collected and routed to the SDI and treated. Reclamation has not been entirely successful in these areas. Routing of this water to the Wightman Fork Diversion (a clean water diversion) would negatively impact water quality in Wightman Fork and the Alamosa River.

- *Enlarge the capacity of the Wightman Fork diversion. It can be greatly increased with some expense but minimal environmental impact to safely pass large storm events. It should be sized to handle not only the current watershed but also be able to bypass additional areas of the site. Proper sizing of the diversion ditch and addition of an emergency spillway to the diversion system would eliminate the problem of the bypass failing into the reservoir thereby greatly reducing downstream risks of a catastrophic release.*

Response: The Selected Remedy includes upgrade of the Wightman Fork Diversion (Section 7.2). The diversion would carry the design event consisting of the 500-year thunderstorm and 100-year snow melt. The diversion would flow into Wightman Fork downstream of the impoundment. The existing Wightman Fork Diversion is designed for only the 10-year storm event.

- *Many of the acid seeps have been present at the site for thousands of years as evidenced by the large ferricrete deposits observed at the seep exit points in the Missionary Seeps area and along the Wightman Fork Creek. Also, the toe of the North Waste Dump is constrained on the northeastern side where the mining company avoided placing mine waste on a large pre- existing seep. This seep is natural and pre-mining and should be released untreated. According to CERCLA remediation funds should not be expended upon treating natural contamination. Some of these natural seeps could go untreated.*

<u>Response</u>: Although these seeps are naturally occurring, they are within the Summitville Mine permit boundary. The water comingles with acid mine drainage related to mining activities. It would be difficult, but possible, to separate the water and discharge it to Wightman Fork. However, the agencies believe that collecting and treating seepage from these areas is justified and it will increase the level of environmental protection.

<u>Mine Pool</u>

<u>Comment</u>: - *A final remedy also should address the actual source. And I know this is difficult within the parameter of Superfund, but we do have a hundred years of underground mining and mining impacts in this site.... The underground workings and the source of the AMD is still basically there.... And we have to take that into consideration, and manage underground mine pool, and the effects of the water levels while they are positive in limiting the amount they can produce over time. I believe that there is an optimum level... that when the level rises too high, then it enters into underground workings that actually deteriorate water quality, and we just generate more volume and more polluted water from the site.* - Mr. Ken Kclo Summitville Technical Assistance Group

<u>Response</u>: The Selected Remedy includes management of the mine pool. The mine pool draw down test conducted in 2000 (Rocky Mountain Consultants, Inc., 2001c) provided useful information on discharge rates that can be achieved through the Reynolds Adit pipeline, the resulting draw down effects in the surrounding bedrock aquifer, and the resulting changes in chemistry of the mine pool and bedrock aquifer due to mine pool draw down. Supplemental testing of the mine pool and draw down effects may be conducted during the Remedial Design phase to aid in estimating an optimal level and management of the mine pool to minimize generation of acid mine drainage. At this time, and based on data from the mine pool draw down test, the mine pool elevation will be maintained below the Chandler Adit. The benefits are: eliminating point sources from the Dexter, Ida and Chandler Adits and reducing seeps below the Chandler Adit. Mine pool management will continue to be evaluated in the future as the final remedy progresses. Important in management of the mine pool is the ability to store and treat the water. For this reason, it may not be possible to manage the mine pool until after the Selected Remedy is fully implemented.

<u>Comment</u>: *One of the things I've noticed on your map of current sites that are releasing acid mine drainage is the Iowa Adit. The Iowa Adit was never an issue when we were first visiting Summitville. It never used to have water coming out of it. Now, it's a source of acid mine drainage*. - Ms. Maya ter Kuile

<u>Response</u>: The Iowa Adit has always issued acid mine drainage since U. S. EPA assumed control of the site in December 1992. The earliest measured flow on record was in June 1984 at 224 gpm. Highest flows are in the early summer and decrease through the summer, eventually stopping in the fall. The source of the acid mine issuing from the adit is from infiltrating snow melt and rain, presumably from a glory hole. In 2000, discharge from the adit was routed through a pipeline to Ditch K that runs along the mine pits. The adit opening was backfilled and reclaimed.

Comment: *The proposed rehabilitation of the Reynolds and Chandler Adits does not address the issue of polluted water behind them. There appears to be a general consensus that the higher the level of water in the mountain the greater the contamination and the greater the volume of nonpoint-source pollution with a significant amount of it bypassing treatment. You have not, to our knowledge, recorded it but you have mentioned keeping the level of the reservoir at or below the Chandler Adit. The latter is preferable and our hope is that it becomes an attainable goal.* - Mr. Ignacio Rodriguez, Summitville Technical Assistance Group

Response: The Selected Remedy includes management of the mine pool to minimize the generation of acid mine drainage (Section 7.0). This management will be accomplished by releasing water from the Reynolds Adit pipeline. The mine pool draw down test conducted in 2000 found short-term benefit in lowering of the mine pool in terms of reducing non-point flows and improved water quality in the surrounding bedrock aquifer. At this time, the data supports maintaining the mine pool elevation below the Chandler Adit. During the Remedial Design phase, additional longer-term testing of the mine pool may be performed to estimate the optimal level of the mine pool that would result in the minimum generation of acid mine drainage.

Comment: *The various polluted water reservoirs on site need to be managed - this includes the mine pool behind the Reynolds and Chandler plugs - which must be kept as low as possible, , the Heap Leach Pad, and the SDI or its successor. In particular, the mine pool reservoir must be kept below the level of the Chandler Adit in order to minimize water pollution generated as mine pool water rises above that elevation. Unfortunately, the present conditions leave untreated release as the only alternative to allowing the mine pool water to rise resulting in more pollution to deal with.* - Mr. Ken Kclo Summitville Technical Assistance Group

Response: The Selected Remedy includes management of the mine pool to minimize the generation of acid mine drainage (Section 7.0). This management will be accomplished by releasing water from the Reynolds Adit pipeline. The mine pool draw down test conducted in 2000 found short-term benefit in lowering of the mine pool in terms of reducing non-point flows and improved water quality in the surrounding bedrock aquifer. During the Remedial Design phase, additional longer-term testing of the mine pool may be performed to estimate the optimal management of the mine pool that would result in the minimum generation of acid mine drainage.

Comment: *The final remedy does not identify an action or actions to be taken to address the source of acid mine production - the underground workings. The final remedy as written addresses a reactionary plan to deal with the pollution but does not identify action which may inhibit or eliminate the source of AMD, such as dewatering the underground workings or injecting limestone or other neutralizing agents into the old mine workings.* - Mr. Ken Kclo Summitville Technical Assistance Group

Response: The preferred alternative in the Proposed Plan did not explicitly identify how the mine pool would be addressed in the future. However, the agencies are committed to managing the mine pool in the future to minimize generation of acid mine drainage. The Section 7.0 of this Record of Decision identifies management of the mine pool as a component of the Selected Remedy. The mine pool draw down test conducted in 2000 found short- term benefit in lowering of the mine pool in terms of reducing non-point flows and improved water quality in the surrounding bedrock aquifer. During the Remedial Design phase, additional longer-term testing of the mine pool may be performed to estimate the optimal management of the mine pool that would result in the minimum generation of acid mine drainage. Management of the mine pool may not be possible until the Selected Remedy is fully implemented, to assure that sufficient storage is available in the on- site impoundment to treat all other sources of site contaminants and acid mine drainage. Injecting limestone or other neutralizing agents into at least 14 acre-feet of void space in the mine pool has a high probability of failure.

Comment: *The final remedy does not address mitigation of conditions at the site as a result of the Interim Actions taken by the EPA and CDPH&E in attempt to reduce the point-source pollution stream which has, in effect, created a large, diffuse, non- point source of pollution which is affecting Wightman Fork and bypassing containment and treatment. The pollution migrating from the toe of the North Waste Dump and the Chandler groin area is entering the Wightman Fork above all possible points of diversion. The elevated water table in South Mountain is helping to create pollution more difficult to contain and collect.* - Mr. Ken Kclo Summitville Technical Assistance Group

Response: The interim actions that included plugging of the Reynolds and Chandler Adits have created non-point sources of acid mine drainage primarily in the Chandler Groin area (a.k.a Chandler Seep Area, Figure 2-5). The Chandler Adit did not flow prior to adit plugging except during snow melt. Now it flows from the spring through the fall. However, the seepage in the Chandler Groin area enters either Ditch A4 or B2 and it is routed to the SDI for treatment (Figure 2-3). Seepage in the Chandler Groin area does not enter Wightman Fork, except for a possible small amount that may seep underneath the ditch. Reconnaissance of the area between Ditches A4 and B2 and Wightman Fork in June 2001 found only five gpm of flow entering Wightman Fork. This small amount could also be leakage out of the ditches. It is only the impacts from this small flow entering Wightman Fork that can be attributed to plugging of the adits.

The seepage from the toe of the North Waste Dump is not caused by rising water levels from adit plugging. The seeps along the toe of the North Waste Dump are historic and pre- date adit plugging. This is evidenced by the vegetation (trees) around some of the seeps indicating that the area was historically wet. Previous operators of the mine avoided placing waste rock in this area because it was, and still is, a boggy area. Furthermore, bedrock monitoring wells in the central portion of the North Waste Dump did not respond to draw down of the mine pool in 2000, indicating that the bedrock aquifer below the majority of the North Waste Dump is not influenced by rising and falling water levels of the mine pool. This lack of response is witnessed by the minimal fluctuation in water levels of the bedrock monitoring wells at the central portion of the North Waste Dump, NPDMW-4 and -4A (Figure 2-4). The difference between seasonal high and low water levels has been consistently about 20 feet in these wells since 1995. In contrast, annual water level fluctuations in wells strongly influenced by the mine pool (i.e., those near the mine pits) typically ranges from 100 to 150 feet. The bedrock wells at the North Waste Dump have annual water level fluctuations more similar to bedrock wells in the Cropsy Creek Valley. For these reasons, the seepage along the toe of the North Waste Dump is not a result of adit plugging.

A wetland area lies between the North Waste Dump and Wightman Fork, which is at an even greater distance from the mine pool (Figure 2-5). It stands to reason that if the mine pool does not influence the seepage along the toe of the North Waste Dump, then the more distant wetland area is not influenced as well. The wetland area contains brown, ferricrete deposits that are up to two-feet thick. A color aerial photograph of the site from 1980 clearly shows these areas to be approximately the same proportion and location as the current ferricrete deposits. The 1980 photo pre-dates adit plugging by 14 years.

Heap Leach Pad

Comment: *We can't forget about a lot of issues on the site, such as the Heap Leach Pad itself, which has not as much polluted water as the underground workings, but still has low quality water of tremendous volume. I mean 93 million gallons of water in the Heap Leach now and that has to be integrated into the final plan.* -Mr. Ken Kclo Summitville Technical Assistance Group

Response: The Selected Remedy does not include additional remedial action at Heap Leach Pad other than continued monitoring of groundwater and the stability of earthen dikes. As stated in Section 7.0 of this Record of Decision, the testing and monitoring of the Heap Leach Pad shows water within it to be substantially isolated from the surrounding environment and its earthen dikes are stable. For these reasons, the agencies believe that the Heap Leach Pad is not an environmental threat and continued monitoring of the Heap Leach Pad, as identified in the Selected Remedy, is the appropriate action at this time. Should conditions change, U. S. EPA and the State will take appropriate action to ensure protection of human health and the environment.

Comment: *The Heap Leach Pad is still of great concern to us but does not appear to be a major consideration to EPA or CDPH& E. We believe it is an " accident" waiting to happen and that the water contained therein should be drawn down and treated in a planned and consistent manner. It remains to be seen whether or not, should a draw down take place, if it would recharge as the underground mine workings do. It would be tremendous if it did not and preliminary indications allow us to hope that such may be the case. Ever the optimist.* - Mr. Ignacio Rodriguez, Summitville Technical Assistance Group

Response: The Selected Remedy does not contain further remedial action at the Heap Leach Pad other than continued water quality and stability monitoring. As discussed in Section 7.0, the Heap Leach Pad was found to be substantially isolated from the surrounding environment. This conclusion is based on results of the Heap Leach Pad pumping test conducted in 2000, during which the groundwater level in the Heap Leach Pad was drawn down about 10 feet. Subsequent monitoring of water levels in June 2001 shows that the water level had recovered only about one foot. Therefore, very little groundwater is recharging the Heap Leach Pad either through the bottom liner or the cap. Discharge from the French Drain, which drains groundwater beneath the Heap Leach Pad, has a few very low detections of cyanide over the past two years. Cyanide has not been detected in any of the downgradient monitoring wells or seeps during the past two years of monitoring. Inclinometers have been installed in Dike No. 1 to monitor subsurface movement and no movement has been measured over the past year. For these reasons, the agencies believe that the Heap Leach Pad does not pose an imminent environmental threat.

Water Quality/Sediments

Comment: *The implementation of the preferred alternative will not achieve the goals of the clean up. The goals of the clean up are to restore capability of over the winter survival. Goals will not be met because the remedy does not address contaminated sediments. The government’s own data establishes that the sediments are heavily contaminated, most of the sediments of the river. The government’s own data shows contaminated sediments that pose a continuing threat to water quality. The government’s own data shows that these sediments will have a detrimental effect of aquatic life. Thus, the agency should include a sediment remediation component to the preferred alternative. The agency should immediately remediate the sediments.* - Ms. Cindy Medina on behalf of the Alamosa River Keepers

Response: The primary goal of the Selected Remedy is to control and treat surface water, groundwater and leachate, as necessary, to meet State and Federal applicable or relevant and appropriate requirements (Section 5.0). If water quality ARARs for the Alamosa River Segment 3c are achieved, the agencies believe that over the winter survival of fish can be attained. Sampling and testing of river sediments showed that the sediments are non-hazardous. The sediments do contain metals. The potential impact of sediments on the environment is measured by their effect on the water and the ability to sustain aquatic life. Sediment sampling in 2000 (Rocky Mountain Consultants, Inc., 2001c) found that the metals bound in sediments were considered to be bioavailable. Because the adsorption of metals to iron oxides is largely pH dependent, maintaining near-neutral pH in the Alamosa River and Terrace Reservoir could maintain sorption of metals onto iron oxides in the sediments and minimize bioavailability. With the existing monitoring data and computer models, the agencies believe that meeting water quality standards in Alamosa River Segment 3c and downstream is achievable with the Selected Remedy. Surface water, sediment and aquatic life will be monitored to assess the performance of the final remedy. At the five-year review, compliance with the ARARs (that have not been waived) and RAOs will be evaluated. If such a review demonstrates that water quality ARARs are not being met due to site-related contamination in river or reservoir sediments, U. S. EPA and the State will evaluate whether removal of these sediments is necessary and appropriate to meet ARARs and RAOs.

Comment: *I'd like to address sediment. I know we already talked about it but I'm going to say it again. It is one of our favorite subjects. It needs to be addressed in more detail. Not only what's already in the stream but also what is still coming downstream*. - Ms. Maya ter Kuile

Response: A comprehensive sampling of Alamosa River instream and bar sediments, and Terrace Reservoir Sediments was conducted in 2000 (Rocky Mountain Consultants, Inc. 2001c). Instream sediment samples (submerged sediments) were collected from four locations along Wightman Fork and 11 locations along the Alamosa River. Bar deposit samples were collected from 14 locations along Wightman Fork. Bar, overbank, and cutbank deposit samples were collected from 71 locations along the Alamosa River. A total of nine bottom sediment samples and three shoreline deposit samples were collected from Terrace Reservoir. Field testing of surface water at instream, overbank, and bottom sediment sampling locations was conducted, inclusive of pH, conductivity, and temperature. Sediments and deposits collected from Wightman Fork and the Alamosa River were field tested by XRF analysis. Analytical tests were conducted to evaluate the particle size distribution, total metals concentrations, metals availability, and select types of mineral phases of the sediments. Sediment and deposit total metals concentrations were evaluated to determine if they could become environmentally available. The agencies believe that this level of detailed sampling combined with computer modeling, currently provides a sufficient basis upon which decisions regarding the need for sediment remediation can be made.

Comment: *Somehow we are picking up aluminum as the stream travels down the stream. When you go to Wightman Fork, you see white stuff on the rocks at certain times of the year and that is because aluminum is the first metal to drop out of the stream as the pH rises. -* Ms. Maya ter Kuile

Response: Precipitation of aluminum onto sediments is highly pH dependent. The white precipitate on Alamosa River sediments immediately downstream of Wightman Fork is probably a hydrous aluminum oxide or hydrous aluminum hydroxy-sulfate. Precipitation of aluminum occurs when Wightman Fork water has a pH high enough that the combined Wightman Fork and Alamosa river waters have a pH greater than about 5.2 (see Use Attainability Analysis). Some of this aluminum is from areas upstream of Wightman Fork.

Comment: *All you mentioned was natural sources upstream of Summitville. And I know there are natural sources, and I agree. There is a couple of things that happen up there. We have a major drainage adit at the passing arm at Iron Creek that is man-made. We also have certain activities, we call them pH streams, which is disturbing some of those stream sediments with the caterpillars. It's not really a classification. It's just called a pH stream.* - Ms. Maya ter Kuile

Response: The agencies acknowledge that not all of the acidic drainage that occurs upstream of Wightman Fork is from naturally occurring sources. The Colorado Geological Survey issued a report stating that the small mineral claims and adits in the upper Alamosa River basin constituted a relatively low percentage of the contamination emanating on this part of the watershed. The abandoned mines could be responsible for *"nearly 11 percent of the iron and almost 18 percent of the aluminum, but only around one percent of the copper, manganese, and zinc in the river above the confluence with Wightman Fork"* (Kirkham, R. M. and Lovekin, J. R., 1995). Remediation of acid mine drainage in areas of the Alamosa River basin that are unrelated to the site is beyond the scope of the Summitville Mine Superfund site Operable Unit 5 remedy.

Comment: *I'd like to ask Austin all this creeks that are Iron Creek and Bitter Creek, I* *remember that my dad used to stop and have us taste the water there. What I'd like to know, are those natural or are those from the mines?* - Unidentified Commenter at Public Meeting

Response: These creeks do not receive drainage from the site, and therefore they are not impacted by mining activities at Summitville. However, several abandoned mines are located within the Iron and Bitter Creek drainages. Both naturally occurring acid rock drainage and acid mine drainage impacts Iron and Bitter Creeks.

Comment: *The sedimentation which has occurred, and continues to occur, as a result of releases of untreated water at Summitville, is still of concern to our community and will continue to be. We believe it should be given more importance than what it has received thus far.* - Mr. Ignacio Rodriguez, Summitville Technical Assistance Group

Response: A comprehensive sampling of Alamosa River instream and bar sediments, and Terrace Reservoir Sediments was conducted in 2000 (Rocky Mountain Consultants, Inc., 2001c). The sampling was initiated by CDPHE to determine if conditions had changed since previous sampling events conducted in 1976 and 1994, in addition to estimating the bioavailability of metals within the sediments. Issuance of the final Remedial Investigation Report was delayed several months so that the sediment information could be collected, interpreted, and included into the final report. The agencies believe that this level of detailed sampling provided a sufficient basis upon which decisions regarding the need for sediment remediation were made.

Comment: *The writer is very happy that the aquatic life, especially the fishes are 100% restored! (In the Summitville Area).* - Comment Card from Mr. Felix A Cordova

Response: The primary goal of the Selected Remedy is to control and treat surface water, groundwater and leachate, as necessary, to meet State and Federal applicable or relevant and appropriate requirement (Section 5.0). The agencies believe that if this goal is met, the restoration of a fishery in Segment 3c of the Alamosa River and downstream will be attained.

Comment: *The issue of impacts on downstream environs will not go away. As long as the existing inadequate storage and treatment systems are employed, it is likely that untreated releases will occur. This increases the likelihood that in-stream sediments or Terrace Reservoir itself may one day be in need of remediation. It is imperative that a final remedy for the site be implemented as soon as possible if for no other reason other than minimizing the possibility of this costly and contentious scenario*. - Mr. Ken Kclo Summitville Technical Assistance Group

Response: U. S. EPA and the State agree with this comment. Accordingly, the Selected Remedy addresses the issues of inadequate storage and treatment, and it allows for the continued monitoring of in-stream and Terrace Reservoir sediments.

Comment: *I was disturbed to read in your June 2001 document "Proposed Plan for Summitville Mine" the statement: "As a result of contaminant releases from Summitville, aquatic life in the Alamosa River was decimated." Public information released by several federal, state and private agencies on water quality in sections of the Alamosa downstream from the Summitville site has shown questionable historic aquatic life prior to the recent Summitville mine debacle. Scientific facts indicate minimal, if any, aquatic life historically existed in Segment B. To categorically state otherwise, is at a minimum, misleading and self-serving of your recommended project objectives. Natural drainage from highly acidic areas in the South Fork, Jasper and Burnt Creek segments of the Alamosa have been shown to contribute a considerable portion of the metal loading to the downstream portion of the river.*

Considerable effort has been taken by the State of Colorado and the U. S. EPA to remediate *the overall Summitville site. Public reports indicate that in excess of $160 million has been expended on this effort to date. While, in the opinion of many informed observers including myself, the amount of expenditure on the site is excessive, the agencies involved are to be complemented in restoring the site to an acceptable standard. Yet your recommendations (Alternative 4-5) indicate an additional $17-24 million will be spent to "improve" aquatic life in the Alamosa. This additional expenditure is unwarranted and unjustified.*

It is my recommendation that <u>only</u> the following additional steps by taken at the Summitville Site:

1. *Ongoing site reclamation efforts be completed as scheduled in 2001;*

2. *Alternative 1B of your site-wide study should be implemented to complete overall site-wide closure at a capital cost not to exceed $ 3.4 million. Your documentation indicates this alternative would leave the site in a safe condition. This step, combined with my recommendation 1 above, should provide for a sufficient, cost-effective final closure of the site; and*

3. *Cease all other studies and expenditures of the Summitville Site and related downstream areas other than normal monitoring activities conducted on other rivers and streams in the state.*

Remediation activities at Summitville have adequately provided for the closure of an area mined since 1870. Further activity at the site by the state and federal government, other than that indicated above, in both unnecessary and unwarranted. - Mr. Paul C. Jones

<u>Response</u>: The agencies do not dispute the existence of limited aquatic life in some segments of the Alamosa River prior to the most recent mining at Summitville. However, fish kills in the Alamosa River were documented in 1990 and these were directly related to releases of contaminants from the mine. The recommendations to implement Alternative 1B (i.e., no further action) and to ceases all expenditures for monitoring activities is not acceptable to the agencies, stakeholders, and community and does not conform to the NCP criteria to protect human health and environment.

<u>Comment</u>: *The Terrace Irrigation Company owns the Terrace Reservoir on private property downstream from the mine site on the Alamosa River, along with 30 miles of canals that the company uses to deliver irrigation water to its 29 stockholders. The Terrace uses nearly 1/4 of the annual flow of the Alamosa River to irrigate 12,000 acres of farmland. The Terrace feels very strongly that the cleanup of the Summitville remain at the site. We feel that there should be no attempt to remove sediment from the Terrace Reservoir. Sediment removal would only contribute to water quality problems below Terrace Reservoir. Also, sediment removal would require taking Terrace Reservoir off line for more than one year, which would bankrupt the 29 farm families that make up the stockholders of the Terrace Irrigation Company. The data on water quality in the Alamosa River has continued to improve over the last 3 years and shows that, as water coming off the mine site improves, so does the water downstream. The data also shows that without exception the water below Terrace Reservoir is always better than above. The sediment in the Reservoir is not causing the water quality to deteriorate. Quite the opposite is true. The Board of Directors of the Terrace Irrigation Company hopes that the EPA and CDPHE take these comments very seriously. The future of our farms depends on it.* -Mr. Ron Reinhardt, President, Terrace Irrigation

<u>Response:</u> The agencies agree that removal of sediment from Terrace Reservoir could possibly have a negative impact on the Alamosa River water users downstream of the reservoir. The water quality in Terrace Reservoir (Section 2.9.2) has significantly improved since remedial response and interim remedial actions have been implemented at the

site. A continued focus on remediation at the site is judged to be the appropriate action at this time that will be protective of human health and the environment.

ARARs

Comment: *The Draft Feasibility was issued in April 2001. Identification of ARARs is a significant element of any feasibility we studied. We commented that the ARAR identification was totally inadequate. We requested a specific identification of ARARs and ARAR waivers, and a release of the Draft Feasibility Study for public comment. The agency redrafted the ARAR section and formally reissued it on June 8, 2001. We received it on June 11. It is over 40 pages long. We have only had 8 days to review the final revisions. This is an inadequate amount of time to review 40 pages of laws, regulations, and guidance that govern this clean up. We renew our request to reissue the draft feasibility study with a new ARARs analyses and to accept public comments on the new ARAR analyses* - Ms. Cindy Medina on behalf of the Alamosa River Keepers

Response: The CDPHE issued a letter on July 2, 2001 requesting comments on the Feasibility Study inclusive of the Appendix E ARARs analysis, allowing more than 30 days for a review. Further, a stakeholders meeting was held in Denver on August 10, 2001 to further solicit the public's input on the Proposed Plan and Feasibility Study. No issues regarding any particular ARAR were raised. Accordingly, a second draft of the Feasibility Study containing an updated ARARs analysis will not be issued. Based on comments received on the Feasibility Study and Proposed Plan, there are no changes to the ARARs analysis. A final Feasibility Study report will be prepared and issued.

Comment: *We object to the waiver of ARAR for the cleanup. The agencies are proposing to waive ARARs in segment 3B. The ARARs that will be waived are pH, aluminum, iron and aquatic life classification. These ARARs should not be waived because; first, the pollution in segment 3B is predominately man-made caused by mining activities. The mines that are causing the pollution in segment 3B were permitted or should have been permitted by the State of Colorado. Many of these mines are also located on federal lands. As such, the State of Colorado and federal government are legally responsible for addressing a solution in segment 3B.* -Ms. Cindy Medina on behalf of the Alamosa River Keepers

Response: The Selected Remedy addresses only impacts associated with the Summitville Mine Superfund site. Remediation of acid mine drainage in areas of the Alamosa River basin that are unrelated to the Summitville Mine is beyond the scope of the Summitville Mine site Operable Unit 5 remedy. Section 8.2.1 provides justification for waivers in Segment 3b. Lastly, U. S. EPA and the State disagree with the commenter's contention that the agencies are "legally responsible" for the "pollution in Segment 3b."

Comment: *Waiver of aquatic life classification amounts to the waiver of goals of the clean up. Again, the goal of this clean up is to restore fishery in all segments of the Alamosa River. The aquatic life classification acknowledges that this segment of river was capable of supporting aquatic life prior to the Summitville disaster. Thus, by waiving the aquatic life classification, the agencies are saying that they are not willing to try and meet their own goals.* - Ms. Cindy Medina on behalf of the Alamosa River Keepers

Response: The primary goal of the Selected Remedy is to control and treat surface water, groundwater and leachate, as necessary, to meet State and Federal applicable or relevant and appropriate requirement (Section 5.0) . The Use Attainability Analysis and reactive transport model of the Alamosa River confirms the agencies' determination that Segment 3b could not support Class 1 aquatic life due to naturally occurring background conditions. Thus, it is technically impracticable to achieve standards in Segment 3b with any remedial scenario at the Summitville Mine Superfund site. If water quality ARARs for the Alamosa River Segment 3c are achieved, the agencies believe that over the winter survival of fish will be attained in Segment 3c and downstream. Waiver of the designated use classification for Segment 3b is consistent with the goals of the Selected Remedy, and does not imply waiver of cleanup goals. The waiver of ARARs is ascribed by the river's water quality and misclassification of this segment, not to any anticipated failure of the site cleanup or the remedy.

<u>Comment</u>: *I believe the water rights up to 960,000 cfs must be treated in some manner. Water users cannot be denied their historical water because of a bottleneck at the treating plant*. Mr. John B. Shawcroft

<u>Response</u>: Water rights are ARARS of the Selected Remedy. The remedy would require the purchase of water rights for the initial filling of the on-site impoundment. Purchase of the necessary water rights would be in accordance with CRS 37-82-101, which regulates water of natural surface streams subject to appropriation for beneficial use. Senior, or first appropriators, downstream of the site will not be denied their full entitlement of water. The on-site impoundment, new water treatment plant and more reliable influent delivery system will provide for better water management than the existing water treatment system at the site. These more effective and efficient engineering controls should ensure that the water rights of downstream users are respected.

<u>Site Maintenance</u>

<u>Comment</u>: *Shouldn't the property owners be responsible for building demolition? What detrimental water quality is being attributed to these buildings?* - Comment Card from Mr. Paul Sinder

<u>Response</u>: Demolition of non-essential site buildings was originally a component of each remedial alternative. Demolition of buildings, however, is not necessary to protect the environment. Therefore, building demolition is not a component of the Selected Remedy.

<u>Comment</u>: *The Forest Service does not want responsibility for the on- site impoundment or water treatment plant if these structures are built on public lands administered by the Forest Service. We would prefer a land(s) exchange with the State for other land(s) of equal value within the Rio Grande National Forest.* - Peter L. Clark, United States Department of Agriculture

<u>Response</u>: The Forest Service would not be responsible for the impoundment, water treatment plant, or other structures. The agencies would be open to discuss a purchase or exchange of land between the State and U. S. Forest. The water treatment plant and other structures associated with the remedy will be located on privately-owned land. As part of the settlement with the current landowners, the State and U. S. EPA will be guaranteed future access to the site.

<u>Comment</u>: *Forest Developed Road (FDR) 244 crosses Wightman Fork near the Summitville Dam Impoundment. How would the location of the new on-site impoundment affect Forest Service access to timber areas? The Forest management prescription for this area is timber production and access could be required for future timber sales. The summary document describes that the Forest Service road will be relocated (p. 10). Will it be relocated on Forest lands or will a right-of-way to this area need to be established?* - Peter L. Clark, United States Department of Agriculture

<u>Response</u>: The new dam would be constructed with a service road along the crest of the dam that would provide access to lands south of Wightman Fork. The road would be similar to the existing road at the dam of the SDI. The road would be within the Summitville Mine Superfund site. A U. S Forest Service right-of-way for use of the road on the new dam would continue.

<u>Comment:</u> *Will Alternative 5 require year- round access by mechanized vehicles? Will the Park Creek Road (FDR 380) provide this year-round access? CDPHE managers must coordinate with Forest officials to develop a long-term agreement regarding access to the Summitville*

Mine Superfund Site. This agreement must include appropriate measures to assure public safety and road maintenance on Park Creek Road. - Peter L. Clark, United States Department of Agriculture

Response: Yes. Park Creek Road (FDR 380) will provide access to the site and water treatment plant on a year-round basis. A road maintenance program will be developed for year-round access to the site and it will specify appropriate safety measures. Coordination and a long-term agreement with the U. S. Forest Service will be developed.

Comment: *Will the monitoring plan include monitoring the Summitville Mine Superfund Site revegetation efforts? In the short-term, revegetation efforts might appear to be successful. However, we are concerned about the long-term ability of the soil to maintain higher pH levels in this strongly acid native soil environment. Continued leaching of base forming cations would allow the soils to become more acidic over time. Species planted on these sites may not thrive under acidifying conditions. The effectiveness of OU4 may actually decrease over time.* Peter L. Clark, United States Department of Agriculture

Response: Yes, the Selected Remedy includes future monitoring of revegetation efforts. It includes costs for monitoring and revegetation of up to five acres of land for five years after the remedy is implemented. Initially, revegetation would likely occur at “hot spots” throughout the site were vegetation has not taken hold.

Reclamation efforts by SCMCI largely failed do to insufficient levels of microbes and organic matter in the topsoil. Limestone and organic amendments were not used by SCMCI (U.S. BOR, 1998). CDPHE engaged revegetation experts from Colorado State University to conduct revegetation experiments. The experiments found that mushroom compost and ground limestone amendments would be more effective in combating the phytotoxic levels of acidity and heavy metals in the subsoil. Vegetation tests have determined that application of compost, limestone, topsoil, fertilizer, seed from native species, and mulch will revegetate the site (Redente and Richard, 1998). This type of soil amendment is being used at the site.

General

Comment: *I just wanted to somehow clarify, there’s a quote here on site back around the first page. “While soils in the San Luis Valley irrigated with Alamosa River Water have been impacted, this impact has been demonstrated to not limit or otherwise adversely affect crop production capacity”. That is not what the soil studies addressed. They did not address crop productivity. They addressed continuing impacts to the soil and continuing change. So I just wanted it to be cleared up and clarified.* - Ms. Maya ter Kuile

Response: This clarification has been noted.

Comment: *We can’t spend a lot of money out of the Superfund to take something out that is coming out of the ground naturally. We need to find another source or legislation to change the law so that the Superfund can spend some of their money, maybe a percentage or something, maybe 10 or 20 percent to clean up some of the natural problems too. Does that make any sense?* - Mr. Jim Snook

Response: Cleanup of natural sources of acid mine drainage in other areas of the Alamosa River basin cannot be provided under the Superfund action at the site. Other avenues may be available for cleanup of natural sources of contamination not associated with the Summitville Mine.

Comment: *I hope the State of Colorado will realize that the Gold Mining in Colorado using the cyanide method of extraction has been without exception a pollution disaster. I do not know of a single mine using cyanide that has not resulted in the State of Colorado and the* *local people being the losers. This, I feel, should be stopped.* - Mr. John B. Shawcroft

Response: Comments about mining industry regulation and the use of cyanide is beyond the scope of this ROD.

Comment: *Please consider this e-mail request to extend the deadline on written public comments on the Summitville Final Proposed Remedial Plan. The current deadline is 5: 00 pm (MT) tomorrow, July 11, 2001. My personal reasons for my request directly concerns your (Ms. Buckingham's) letter addressed to me July 2, 2001. You were requesting a written comment from me by July 11, 2001 on this Summitville Plan. As you both know my family has riparian land on the Alamosa River located in area 3-b (Jasper). Since the proposed plan will make downgrade standard changes to area 3-b I had previously request from CDPHE and the EPA Superfund Record Center (both in Denver) a copy of the Appendix E (and any companion tables). The CDPHE website (inside the pdf format of the 2001 Proposed Plan) stated the Appendix E and tables were not to found inside the CDPHE website. I only received the Appendix E and tables (and map of Alamosa River areas) from EPA this last Saturday. Three days prior CDPHE did finally send me the e-mail attachments in correct pdf format, but without the reformatted Alamosa River map. It is hopefully obvious that I (and the rest of Alamosa River Stakeholders) need more time to digest/share info and formally make comments to this vital Proposed Summitville Plan. Please update your website, adding a link to pdf formatted files on Appendix E, tables, and the Alamosa River Segment Map so the entire public can conveniently read and discuss it with relatives, neighbors or friends. Thank you both.* - Mr. Mike Bryce

Response: The public comment period for the Proposed Plan was extended from July 11, 2001 to August 10, 2001 to accommodate this request.

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TABLES

TABLE 2-1

MAJOR ON-SITE SOURCE AREAS AND AFFECTED MEDIA

C	Af	D
Heap Leach Pad	Water	Approx. 290 acre-feet of water at an elevation of 11,528 feet; contains low concentrations of cyanide
	Sediment	6.5 million cubic yards of ore and water rock
Summitville Dam Impoundment	Surface Water	275 acre-feet at normal high water elevation of 11,220 feet; low pH and high metals concentrations
	Sediment	Unknown quantity
Bedrock Aquifer	Groundwater	Approx. 147 acre-feet of water with low pH high metals concentrations
Mine Pool	Groundwater	Approx. 14 acre-feet of water with low pH high metals concentrations
Adits	Groundwater	Reynolds Adit discharge ranges from 20 to 120 gpm in the summer; low pH and high metals concentrations
		Chandler Adit discharge ranges from 0 to 40 gpm in the summer; low pH and high metals concentrations
French Drain	Groundwater	Discharge ranges from 20 to 190 gpm; low pH and moderately high metals concentrations
Pumphouse Fault	Groundwater	Discharge ranges from 10 to 60 gpm; low pH and high metals concentrations
Site-Wide Seepage	Groundwater	Peak flows during wet year totals 300 gpm and about 90 gpm in dry years; low pH and high metals concentrations particularly in the Missionary Seeps area
Highwall	Surface Water Runoff	50 acres of exposed, highly altered rock generating AMD
Beaver Mud Dump	Surface Water Runoff	18 acres of exposed waste material
	Groundwater	Seepage ranges from 10 to 30 gpm; low pH moderately high metals concentrations
North and South Mine Pits	Groundwater	Approximately 4 million cubic yards of waste rock and mine wastes that are periodically saturated; low pH and high metals concentrations
North Waste Dump	Groundwater	Approximately 3.2 million cubic yards of waste rock; only minimally saturated along the toe where seepage ranges from 5 to 30 gpm; low pH and high metals concentrations
Sludge Disposal Area	Surface Water	Ponded water collects and is piped to the SDI; low pH and high metals concentrations
	Sediment	Approximately 20,000 cubic yards of sludge from WTP (1996 through 2000); sediments are non-hazardous
Unreclaimed Roads	Surface Water Runoff	Unknown acreage

TABLE 2-2
CONCENTRATOINS OF COCs AND OTHER COMPOUNDS IN SURFACE WATER AND GROUNDWATER FOR SUMMITVILLE MINE SITE AND DOWNSTREAM AREAS (1999 AND 2000 FIELD SEASONS)[1]
(Page 1 of 3)

Analyte (mg/L)	*Area 1 On-Site*				*Area - Wightman Fork*	
	Surface Water		*Groundwater*		*Surface Water*	
	Min	*Max*	*Min*	*Max*	*Min*	*Max*
Aluminum (D)	<MDL	101	<MDL	528	<MDL	3.55
Aluminum (TR)	0.11	61			1.43	32.4
Arsenic (D)	<MDL	0.05	<MDL	5.4	<MDL	<MDL
Arsenic (TR)	<MDL	0.07			<MDL	0.012
Cadmium (D)	<MDL	0.081	<MDL	0.464	0.0008	0.0051
Cadmium (TR)	<MDL	0.01			<MDL	0.0048
Copper (D)	<MDL	26.3	<MDL	348	0.03	1.26
Copper (TR)	<MDL	219			0.16	1.15
Copper (T)	0.005	147.7				
Cyanide, Total	<MDL	0.05	<MDL	10	0.02	0.02
Cyanide, Free	<MDL	0.1	<MDL	18.9	<MDL	<MDL
Cyanide, WAD	<MDL	0.194	0.23	9.6		
Iron (D)	0.19	101	<MDL	1290	<MDL	3.76
Iron (TR)	0.01	936			0.76	73.5
Iron(T)	0.026	1030				
Lead (D)	<MDL	0.04	<MDL	0.6	<MDL	0.008
Lead (TR)	<MDL	0.14			<MDL	0.05
Manganese (D)	0.01	25.3	<MDL	244	0.4	3.38
Manganese (TR)	<MDL	41.7			0.53	2.97
Manganese (T)	<MDL	38.9				
Nickel (D)	<MDL	0.53	<MDL	1.98	0.01	0.04
Nickel (TR)	<MDL	0.11			<MDL	0.04
Nitrate/Nitrite	0.07	1.1	<MDL	2.21	0.7	0.72
Nitrite	<MDL	<MDL				
Nitrogen, Ammonia	<MDL	3.43	<MDL	29.3	1.36	1.4
Sulfate	<MDL	4600	10	7160	56	890
Thiocyanate	<MDL	3.8	<MDL	88	<MDL	<MDL
Zinc (D)	<MDL	11.6	<MDL	72.9	0.04	0.89
Zinc (TR)	<MDL	44.3			0.09	0.86
Zinc (T)	0.011	49				
pH (s.u.)	2.18	9.52	2.33	12.63	4.47	7.8
Specific Cond. (uS)	1.2	4640	130	8390	161	1107

TABLE 2-2
CONCENTRATOINS OF COCs AND OTHER COMPOUNDS IN SURFACE WATER AND GROUNDWATER FOR SUMMITVILLE MINE SITE AND DOWNSTREAM AREAS (1999 AND 2000 FIELD SEASONS)[1]
(Page 2 of 3)

Analyte (mg/L)	*Area 3 – Alamosa R. Below Mouth of Wightman Fork To Terrace Reservoir*				*Area 4 – Terrace Reservoir*			
	Surface Water				*Surface Water*			
	Min	*Max*	*Count*	*Exceedance*	*Min*	*Max*	*Count*	*Exceedance*
Aluminum (D)	<MDL	1.27	11	5	<MDL	<MDL	8	0
Aluminum (TR)	0.29	9.73			0.03	1.53		
Arsenic (D)	<MDL	<MDL	4	0	<MDL	<MDL	4	0
Arsenic (TR)	<MDL	0.04			<MDL	0.0006		
Cadmium (D)	<MDL	0.001	11	2	<MDL	0.0016	8	1
Cadmium (TR)	<MDL	0.0017			<MDL	0.001		
Copper (D)	<MDL	0.208	11	11	<MDL	0.02	8	2
Copper (TR)	0.0125	0.23			<MDL	0.04		
Copper (T)								
Cyanide, Total								
Cyanide, Free								
Cyanide, WAD								
Iron (D)	<MDL	3.4			<MDL	0.22		
Iron (TR)	0.39	21.9	11	2	0.09	2.02	8	5
Iron(T)								
Lead (D)	<MDL	0.0008	11	1	<MDL	0.0013	8	0
Lead (TR)	<MDL	0.0147			<MDL	0.0011		
Manganese (D)	0.16	0.882	11	0	0.207	0.624	8	8
Manganese (TR)	0.18	0.937			0.206	0.577		
Manganese (T)								
Nickel (D)	<MDL	0.74[2]	4	1	<MDL	<MDL	4	0
Nickel (TR)	<MDL	0.01			<MDL	<MDL		
Nitrate/Nitrite								
Nitrite								
Nitrogen, Ammonia								
Sulfate	28.6	240			41.1	170		
Thiocyanate								
Zinc (D)	<MDL	0.2	11	6	0.02	0.09	8	0
Zinc (TR)	0.03	0.18			0.02	0.08		
Zinc (T)								
pH (s.u.)	4.88	7.06	11	10	6.39	7.46	8	1
Specific Cond. (uS)	100	490			118	359		

TABLE 2-2
CONCENTRATOINS OF COCs AND OTHER COMPOUNDS IN SURFACE WATER AND GROUNDWATER FOR SUMMITVILLE MINE SITE AND DOWNSTREAM AREAS (1999 AND 2000 FIELD SEASONS)[1]
(Page 3 of 3)

	Area 5 – Alamosa River Below Terrace Reservoir				*Area 3 and 5 – Domestic Wells*			
Analyte (mg/L)	*Surface Water*				*Groundwater*			
	Min	*Max.*	*Count*	*Exceedance*	*Min*	*Max*	*State Human Health Standard[3]*	*State Secondary Drinking Water Standard*
Aluminum (D)	<MDL	0.09	10	0	<MDL	<MDL		
Aluminum (TR)	<MDL	2.26			<MDL	0.95		
Arsenic (D)	<MDL	0.0009	4	0	<MDL	<MDL	0.05	
Arsenic (TR)	<MDL	0.0005			<MDL	0.095		
Cadmium (D)	<MDL	0.0004	10	0	<MDL	<MDL	0.005	
Cadmium (TR)	<MDL	0.0012			<MDL	<MDL		
Copper (D)	<MDL	0.009	10	2	0.04	0.04		1
Copper (TR)	<MDL	0.04			<MDL	0.041		
Copper (T)					<MDL	<MDL		
Cyanide, Total								
Cyanide, Free								
Cyanide, WAD								
Iron (D)	<MDL	0.11			0.03	0.03		0.3
Iron (TR)	0.09	2.72	10	4	<MDL	1.06		
Iron (T)					0.06	0.06		
Lead (D)	<MDL	0.0002	10	0	<MDL	<MDL	0.05	
Lead (TR)	<MDL	0.0011			<MDL	<MDL		
Manganese (D)	0.044	0.546	10	8	0.009	0.009		0.05
Manganese (TR)	0.045	0.534			<MDL	0.79		
Manganese (T)					<MDL	3		
Nickel (D)	<MDL	0.01	4	0	<MDL	<MDL	0.1	
Nickel (TR)	<MDL	<MDL			<MDL	<MDL		
Nitrate/Nitrite								
Nitrite								
Nitrogen, Ammonia								
Sulfate	41.2	170			30	180		250
Thiocyanate								
Zinc (D)	<MDL	0.07	10	0	0.15	0.15		5
Zinc (TR)	0.01	0.07						
Zinc (T)					0.02	2.8		
pH (s.u.)	5.72	7.56	10	3	7	8.52		6.5 - 8.5
Specific Cond. (uS)	79	308			250	530		

Notes:
Concentrations are in mg/L.
Bolded analytes are COCs evaluated in either Tier 1 or 2 Ecological Risk Assessments.
Count = number of times locations were sampled and tested for a particular analyte.
Exceedance = number of times State of Colorado acute or chronic aquatic water quality standard was exceeded, or number of times the pH was below the range of 6.5 to 9. Numeric Standards are contained in Appendix E of the FS.
D = dissolved; TR = total recoverable; T = total; <MDL = below Method Detection Limits.
Area 1 includes data from on-site surface water sampling locations and monitoring wells.
Area 2 surface water data are from monitoring location WF0.0.
Area 3 surface water data are from monitoring locations AR43.6, AR41.2, and AR34.5.
Area 4 surface water data are from sampling location T1A
Area 5 surface water data from monitoring locations AR31.0 and AR21.6; AR21.6 not sampled in 1999.
1. Groundwater concentrations for domestic wells in Areas 3 and 5 are based on all available data.
2. Value is anomalously high and judged to be unusable.
3. Federal drinking water standard for arsenic has been recently lowered to 0.01 mg/L.

TABLE 2-3

CONCENTRATIONS OF COCs AND OTHER COMPOUNDS IN STREAM SEDIMENTS FOR AREAS DOWNSTREAM OF THE SUMMITVILLE MINE SITE

An	Area 2				Area 3				Are				Area 5			
	Ins		Ba		Ins		B		B		S		Ins		B	
	Mi	M	Mi	M	Mi	M	Mi	M	Mi	M	Mi	M	Mi	M	Mi	M
Aluminum	7,390	24,000	6,470	7,620	8,810	14,300	6,270	9,790	15,500	29,700	9,600	14,600	11,200	11,400	7,260	8,610
Arsenic	23.7	33.8	34.4	872	5.5	10.9	5.3	16.8	15.2	38	5.5	12.1	6.4	10.8	7	9.3
Cadmium	0.6	1	<0.3	4.3	<0.3	1.7	3	4.3	3.7	9	3.1	4.1	1.7	2.2	3.9	4.7
Copper	172	784	191	362	25	378	20	132	520	1,600	160	487	239	307	159	206
Iron	40,600	60,400	33,400	41,500	34,000	66,700	30,900	42,500	38,300	103,000	26,300	41,100	60,200	65,800	29,600	44,300
Lead	47	67	51	137	19	30	14	33	29	42	25	33	17	28	16	17
Manganese	583	798	479	797	277	956	351	520	304	2,780	397	1,170	1,590	1,610	787	1,480
Nickel	8	13	6	9	5	13	5	9	12	38	10	14	20	23	13	17
Zinc	130	220	106	166	39	188	46	119	163	476	134	256	198	218	131	170

Notes:
Samples were collected during 2000 field season.
Concentrations are in mg/kg
<0.03 = below indicated Method Detection Limits

TABLE 4-1

SUMMARY OF CHEMICAL-SPECIFIC ARARs SELECTED FOR THE FINAL REMEDIAL ACTION

Standard, Requirement Criteria, or Limitation	Citation	Applicable or Relevant and Appropriate	Description/Comments
Federal Water Quality Criteria	40 CFR Part 131 Quality Criteria for Water, 1986, pursuant to 33 USC § 1314	Relevant and Appropriate	Sets standards for surface water to protect aquatic life and human health. See Section E.4.1.1.
Colorado Water Quality Standards	5 CCR 1002-31, §§ 31.11	Applicable	Sets standards and classifications for surface water. Primary ARAR for final remedy. See Section E.4.1.1.
Colorado Classification and Numeric Standards for Rio Grande Basin	5 CCR 1002-36	Applicable	Classification and numeric standards for the San Juan and Rio Grande Rivers, including tributaries and standing bodies of water. Classification identifies actual beneficial uses of water and allowable concentrations of various parameters. See Section E.4.1.1
Basic Standards and Methodologies for Surface Water	5 CCR 1002-31	Applicable	Provides basic standards, antidegradation rule, implementation process, and system for classifying surface water, assigning water quality standards and review of classifications and standards.
Colorado Groundwater Standards	5 CCR 1002-41 §§ 41.4 and 41.5	To Be Considered	Sets standards for contaminants in groundwater. Applicable only to protect surface water. See Section E.4.1.2
Clean Air Act, National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50, pursuant to 42 USC § 7409. State: CRS § 25-7-108, 5. CRR 1001-14	Applicable	Sets standards for air emissions.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-10 Part C(I) and (II), Reg. 8	Applicable	Same as above.
Proposed Soil Remediation Objectives Policy Document	CDPHE HMWMD, December 31, 1997	To Be Considered	Proposes guidance in establishing soil cleanup standards.
Provisional Implementation Guidance for Determining Sediment Deposition Impacts to Aquatic Life in Streams and Rivers	Colorado Water Quality Control Commission Policy 98-1, June 1998	To Be Considered	Guidance for assessing impacts to aquatic life and habitat conditions caused by human induced erosion and deposition of materials in aquatic systems.

TABLE 4-2

SUMMARY OF ACTION-SPECIFIC ARARs SELECTED FOR THE FINAL REMEDIAL ACTION

Standard, Requirement Criteria, or Limitation	Citation	Applicable or Relevant and Appropriate	Description/Comments
Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (RCA)	40 CFR Part 257, Subpart A: § 257.1-1 Floodplains, paragraph (a); § 257.3-7 Air, paragraph (b)	Applicable	Regulates the storage and handling of solid waste.
Colorado Solid Waste Disposal Sites and Facilities Act	6 CCR 1007-2, pursuant to CRS § 30-20-101, et.seq.	Applicable	Establishes standards for the licensing, locating, constructing, and operating solid waste facilities. Water treatment sludge is a solid waste. See Section E.4.2
Guidelines for the Land Disposal of Solid Wastes	40 CFR Part 241, pursuant to 42 USC § 6901, et. seq.	To Be Considered	Regulates the land disposal of solid waste.
Guidelines for the Storage and Collection of Residential, Commercial, and Institutional Solid Waste	40 CFR Part 243, pursuant to 42 USC § 6901, et.seq.	To Be Considered	Establishes guidelines for the collection of residential, commercial, and institutional solid waste.
Guidelines for Development and Implementation of State Solid Waste Management Plans	40 CFR Part 256, pursuant to 42 USC § 6901, et seq.	To Be Considered	Establishes guidelines for Federal approval of State solid waste management programs.
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257, pursuant to 42 USC § 6901, et.seq.	Applicable	Establishes criteria for solid waste disposal facilities and solid waste management. See Section E.4.2
Identification and Listing of Hazardous Waste	40 CFR Part 261, pursuant to 42 USC § 6921 State: 6 CCR 1007-3 Part 261, pursuant to CRS § 25-15-302	Applicable	Establishes the procedures and process for listing and determining hazardous waste.
National Pollutant Discharge Elimination System	40 CFR Parts 122, 125, pursuant to 33 USC § 1342	Relevant and Appropriate	Regulates the discharge of treated effluent and storm water runoff to waters of the U.S. See Section E.4.2.
Effluent Limitations	40 CFR Part 440, pursuant to 33 USC § 1311; State: 5 CCR 1002-3, § § 10.1 to 10.1.7, pursuant to CRS § 25-8-503	Relevant and Appropriate	Sets standards for discharge of treated effluent to waters of the U.S. and State of Colorado.
Colorado Mined Land Reclamation Act	CRS 34-32-101 to 125 Rule 3 of Mineral Rules and Regulations	Applicable	Regulates all aspects of mining, including reclamation plans and socioeconomic impacts. See Section E.4.2
Colorado Discharge Permit System	CCR 1002-61	Applicable	Implementation of the Colorado Water Quality Control Act, and applies to operations discharging to waters of the state from a point source. See Section E.4.2.
Colorado Water Quality Control Act. Storm Water Discharge Regulations	5 CCR 1002-61	Applicable	Regulates discharge of storm water during construction activities. See Section E.4.2
Regulations on the Collection of Aquatic Life	2 CCR 406-8. Ch. 13, Article III, Section 1316	Applicable	Establishes requirements for collection of biological samples.

TABLE 4-2 (cont.)

SUMMARY OF ACTION-SPECIFIC ARARs SELECTED FOR THE FINAL REMEDIAL ACTION

Standard, Requirement Criteria, or Limitation	Citation	Applicable or Relevant and Appropriate	Description/Comments
Protection of Fishing Streams	CRS 33-5-101 - 107	Applicable	Establishes notification requirements for modifications to streams.
Appropriation and Use of Water	CRS 37-82-101 - 106	Applicable	Establishes rights to water in the State of Colorado. See Section E.4.2.
Occupational Safety and Health Act	29 USC §§ 651-678	Applicable	Regulates worker health and safety.
Reservoirs and Rules and Regulations for Dam Safety and Dam Construction	CRS 37-87-101 - 125, 37-80-(11k), and 24-4-103	Applicable	Establishes rules and regulations for the design, construction, and operation of dams and reservoirs. See Section E.4.2.
Water Rights Determination and Administration	CRS 37-92-101 - 602	Applicable	Administers Colorado water rights. See Section E.4.2.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-3; Section III.D.l.b.c.d; Sections II.D. 2.b.c.e.f g.; Reg. 1	Applicable	Regulates fugitive emissions during construction.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-5, Regulation 3 APENs	Applicable	Establishes requirements for obtaining permits.
Colorado Air Pollution Prevention and Control Act	5 CCR 1001-4, Regulation 2 Odors	Applicable	Regulates generation of odors.
Colorado Passive Treatment of Mine Drainage Control Regulation	5 CCR 1002-83, Regulation No. 83	Applicable	Regulates passive mine drainage treatment systems. See Section E.4.2.

TABLE 4-3

SUMMARY OF LOCATION-SPECIFIC ARARs SELECTED FOR THE FINAL REMEDIAL ACTION

Standard, Requirement Criteria, or Limitation	Citation	Applicable or Relevant and Appropriate	Description/Comments
National Historic Preservation Act (NHPA)	16 USC § 470 et seq. A portion of 40 CFR § 6.301(b), 30 CFR Part 63, Part 65, Part 800	Applicable	Regulates impacts to historic places and structures. Summitville Town site protection will be required.
Colorado Register of Historic Places	CRS §§ 24-80.1-101 to 108	Applicable	The State historic preservation officer reviews potential impacts to historic places and structures.
The Historic and Archaeological Data Preservation Act of 1974	16 USC 469 40 CFR § 6.301(c)	Applicable	Protects sites with archeological significance.
Historic Sites Act of 1935, Executive Order 11593	16 USC §§ 461 et.seq. 40 CFR § 6.301(a)	Applicable	Regulates designation and protection of historic places.
The Archaeological Resources Protection Act of 1979	16 USC §§ 470aa-47011	Applicable	Regulates removal of archeological resources from public or tribal lands.
Colorado Historical, Prehistorical, and Archaeological Resources Act	CRS §§ 24-80-401 to 410 1301 to 1305	Applicable	Regulates prehistoric and archeological resources on State lands.
Executive Order No. 11990 Protection of Wetlands	40 CFR § 6.302(a) and Appendix A	Applicable	Minimizes impact to wetlands.
Executive Order No. 11988 Floodplain Management	40 CFR § 6.302 and Appendix A	Applicable	Regulates construction in floodplains.
Section 404, Clean Water Act (CWA)	33 USC 1251 et.seq. 33 CFR Part 330	Applicable	Regulates discharge of dredge or fill materials into waters of the U.S.
Fish and Wildlife Coordination Act	16 USC § 661 et.seq. 40 CFR § 6.302(g)	Applicable	Requires coordination with Federal and States agencies to provide protection of fish and wildlife.
Endangered Species Act	16 USC §§ 1531-1543 50 CFR Parts 17, 402 40 CFR § 6.302(b)	Applicable	Regulates the protection of threatened or endangered species.
Non-game, Endangered or Threatened Species Act	CRS §§ 33-2-101 to 108	Applicable	Standards for regulation of non-game wildlife and threatened and endangered species.
Colorado Natural Areas	Colorado Revised Statutes, Title 33 Article 33, Section 104	Applicable	Maintains a list of plant species of "special concern". Recommends coordination among Division of Parks and Outdoor Recreation.
Colorado Species of Special Concern and Species of Undetermined Status	Colorado Division of Wildlife Administrative Directive E-1, 1985. modified	Applicable	Protects species listed on the Colorado Division of Wildlife generated list.
Colorado Wildlife Enforcement and Penalties	CRS §§ 33-1-101, et.seq.	Applicable	Prohibits actions detrimental to wildlife.
Wildlife Commission Regulations	2 CCR 405-0	Applicable	Establishes specific requirements for protection of wildlife.
Wild and Scenic Rivers Act	16 USC §§ 1271-1287 40 CFR § 6.302(e) 36 CFR Part 297	Applicable	Establishes requirement to protect wild, scenic, or recreational rivers.

TABLE 6-1

COMPARISON OF REMEDIAL ALTERNATIVES FOR SUMMITVILLE MINE SUPERFUND SITE

Comparison Criteria	*Alternatives*				
	1A- No Action and 1B - No Further Action/ Breach Summitville Dam Impoundment	**2 - Clean Water Diversion/New Dam Below Confluence/Passive Water Treatment**	**3- Upgrade Summitville Dam Impoundment/Existing Water Treatment Facility with Seasonal Treatment**	**4 - Upgrade Summitville Dam Impoundment/New On-Site Water Treatment Plant with Flexible Treatment Season**	**5 - New Dam Upstream of Confluence/New Gravity-Fed Water Treatment Plant with Flexible Treatment Season**
Protection of Human Health and the Environment	Not protective of human health and the environment because significant AMD would continue.	Possibly protective of human health, but not protective of the environment because passive treatment has not proven to be effective.	Protective of human health, but not protective of the environment because significant AMD would continue	Protective of human health and the environment because most all AMD would be contained and treated.	Highest protection of human health and the environment because most all AMD would be contained and treated.
Compliance with Chemical Specific ARARs	Will not comply with water quality ARARs; waiver of water quality standards would be required.	Compliance with water quality ARARs is unproven; waiver of water quality standards would be required.	Does not comply with water quality ARARs; waiver of water quality standards would be required.	High probability of complying with water quality ARARs; waiver of water quality standards would be required.	Highest probability of complying with ARARs; waiver of water quality standards would be required.
Compliance with Action Specific ARARs	Will comply with minimum requirements; or requirement s do not apply; Alternative 1A will not comply with SEO dam regulations.	Will comply with ARARs; some ARARs do not apply.	Will comply with ARARs	Will comply with ARARs	Will comply with ARARs
Compliance with Location Specific ARARs	Will comply with minimum requirements.	Will comply with ARARs	Will comply with ARARs	Will comply with ARARs	Will comply with ARARs
Long-Term Effectiveness and Permanence	Minimal long-term effectiveness; point and non-point sources would continue to discharge AMD.	Unproven due to undemonstrated reliability of passive water treatment.	Low effectiveness due to frequent releases of untreated water during years of normal to above normal precipitation; problematic water treatment.	Moderate to high effectiveness, but unable to store and treat additional AMD.	Highest because it is able to store and treat additional AMD; gravity-fed delivery systems has high reliability.
Reduction of Toxicity, Mobility or Volume	Minimal reduction in mobility and volume, no reduction in toxicity.	Moderate to low reduction; 32 to 34 percent reduction in copper compared to Alternative 1A/1B.	Moderate reduction, but frequent releases of untreated water could occur; 60 to 90 percent reduction in copper compared to Alternative 1A/1B.	High because new Water Treatment Plant reduces volume of sludge produced, but unable to store and treat additional drainage; 86 to 97 percent reduction in copper compared to Alternative 1A/1B.	Highest because new Water Treatment Plant reduces volume of sludge produced; able to store and treat additional drainage; 88 to 97 percent reduction in copper compared to Alternative 1A/1B.
Short-Term Effectiveness	Least effective because contaminated sediments and AMD would immediately impact Wightman Fork.	Low effectiveness due to considerable disturbance within Wightman Fork during construction of new dam.	Moderate to high effectiveness because disturbances in Wightman Fork minimal, but releases of untreated water would significantly lower the effectiveness.	Moderate to high effectiveness because remedial action would cause minimal disturbances. Disturbances would be less than Alternative 5.	Moderate effectiveness because some disturbances withing Wightman Fork would occur during construction of new dam..
Implementability	Could be readily implemented.	Least implementable due to construction of large dam and purchase of substantial water rights.	Easiest to implement because current site operations are continued with little additional work.	Moderately implementable.	Moderately implementable, requiring a greater level of effort due to the new dam.
Cost ***Total Present Value:***	Lowest total present value. *1A - $9,696,000* *1B - $16,637,000*	Lowest O&M costs *$35,534,000*	Highest total present value and highest O&M costs *$85,423,000*	Second highest O&M costs *$72,939,000*	Highest Capital Costs *$75,409,000*

TABLE 7-1
COST ESTIMATE FOR SELECTED REMEDY - CAPITAL COSTS

Site: Summitville Mine Superfund Site
Location: Rio Grande County, Colorado
Phase: Remedial Action/Feasibility Study (-30% to +50%)
Base Year: 2001
Date: 8/17/01

Description: New Dam Upstream of Wightman Fork-Cropsy Creek Confluence/ New Gravity-Fed Water Treatment Plant with Flexible Treatment Season
Project Years: 0-10 (2001- 2011)

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST		TOTAL
Mobilization/Demobilization	5%			$756,000	
				SUBTOTAL:	$756,000
SDI Breach	1	LS		$229,000	
				SUBTOTAL:	$229,000
Reynolds Adit Rehabilitation	1	LS		$1,333,000	
				SUBTOTAL:	$1,333,000
Source Mitigation					
Interceptor Drain	4120	LF	$124	$511,000	
GCL Ditch - Highwall	1	LS	$51,000	$51,000	
Contaminated Water Pipeline	4500	LF	$72	$324,000	
Concrete Impact Basin	1	LS	$43,000	$43,000	
				SUBTOTAL:	$929,000
Clean Water Diversions					
Ditch P	1	LS	$165,000	$165,000	
Upgrade L Ditch	1	LS	$146,000	$146,000	
Wightman Fork	1	LS	$766,000	$766,000	
				SUBTOTAL:	$1,077,000
Relocate Forest Service Road					
Road Construction	2500	LF	$92	$230,000	
Seeding and Reveg	2	Acre	$10,500	$21,000	
Culverts	4	Each	$5,000.00	$20,000	
				SUBTOTAL:	$271,000
80 ft. Dam, 390 ac-ft	1	LS		$4,551,000	
				SUBTOTAL	$4,551,000
Construct Water Treatment Plant					
Building & Equipment	1	LS		$5,063,000	
Infrastructure/Foundation	1	LS	$750,000.00	$750,000	
				SUBTOTAL:	$5,813,000
Water Rights					
Purchase for Initial Fill	405	Ac-Ft	$400	$162,000	
				SUBTOTAL:	$162,000
SUBTOTAL					$15,121,000
Contingency (scope+bid)	30%				$4,536,300
				SUBTOTAL	$19,657,300
Project Management	5%				$982,900
Remedial Design	6%				$1,179,400
Construction Management	6%				$1,179,400
				SUBTOTAL	$3,341,700
TOTAL CAPITAL COST					**$22,999,000**

(All subtotal and total costs rounded to nearest $1,000)

TABLE 7-1
COST ESTIMATE FOR SELECTED REMEDY - SHORT TERM O&M AND PERIODIC COSTS

Site: Summitville Mine Superfund Site Location: Rio Grande County, Colorado Phase: Remedial Action/Feasibility Study (-30% to +50%) Base Year: 2001 Date: 8/17/01	Description: New Dam Upstream of Wightman Fork-Cropsy Creek Confluence/ New Gravity-Fed Water Treatment Plant with Flexible Treatment Season Project Years: 0-10 (2001- 2011); Discount Factor = 4.2 %	**Page 2 of 3**

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**Net Present Value (4.2%)**	**TOTAL**
Site Monitoring					
Surface Water (years 0 - 10)	4	EVENT	$44,000	$1,473,000	
Groundwater (years 0 - 10)	1	EVENT	$44,000	$368,000	
Geotechnical (years 0 - 10)	1	EVENT	$17,000	$142,000	
				SUBTOTAL:	$1,983,000
Site Maintenance					
Grade Roads (Years 0-10)	1	LS	$5,000	$42,000	
Revegetation (Years 0-4)	5	ACRE	$25,000	$577,000	
Clean and Maintain (Years 0-10)	1	LS	$21,000	$176,000	
Maintain/Inspect Adits (Years 0-10)	1560	LF	$30	$393,000	
New Water Treatment Plant (Years 0-10)	1	LS	$850,000	$7,113,000	
				SUBTOTAL:	$8,301,000
Contingency (% sum)	30%				$3,085,200
				SUBTOTAL:	$13,369,000
Project Management (% sum)	5%				$668,450
Technical Support (% sum)	12%				$1,604,280
				SUBTOTAL:	$2,273,000
TOTAL ANNUAL O&M COST					**$15,642,000**

PERIODIC COSTS:

DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**Net Present Value (4.2%)**	**TOTAL**
Five Year Review	1	LS	$12,000	$10,000	
Update Site Database	1	LS	$12,000	$10,000	
Remedial Action Report	1	LS	$12,000	$10,000	
				SUBTOTAL:	$30,000
Project Management (% sum)	5%				$1,500
Technical Support (% sum)	12%				$3,600
				SUBTOTAL:	$5,000
TOTAL PERIODIC COST					**$35,000**
TOTAL PRESENT VALUE OF SHORT-TERM O&M:					**$15,677,000**

(All subtotal and total costs rounded to nearest $1000)

TABLE 7-1
COST ESTIMATE FOR SELECTED REMEDY - LONG TERM O&M AND PERIODIC COSTS

Site: Summitville Mine Superfund Site
Location: Rio Grande County, Colorado
Phase: Long-Term/Feasibility Study (-30% to +50%)
Base Year: 20001 (Unit Costs Inflated to Year 2011 Dollars at 3.5%)
Date: 8/17/01

Description: New Dam Upstream of Wightman Fork-Cropsy Creek Confluence/ New Gravity-Fed Water Treatment Plant with Flexible Treatment Season
Project Years: 11-101 (2011- 2101); Discount Factor = 4.2%

OPERATION AND MAINTENANCE COSTS

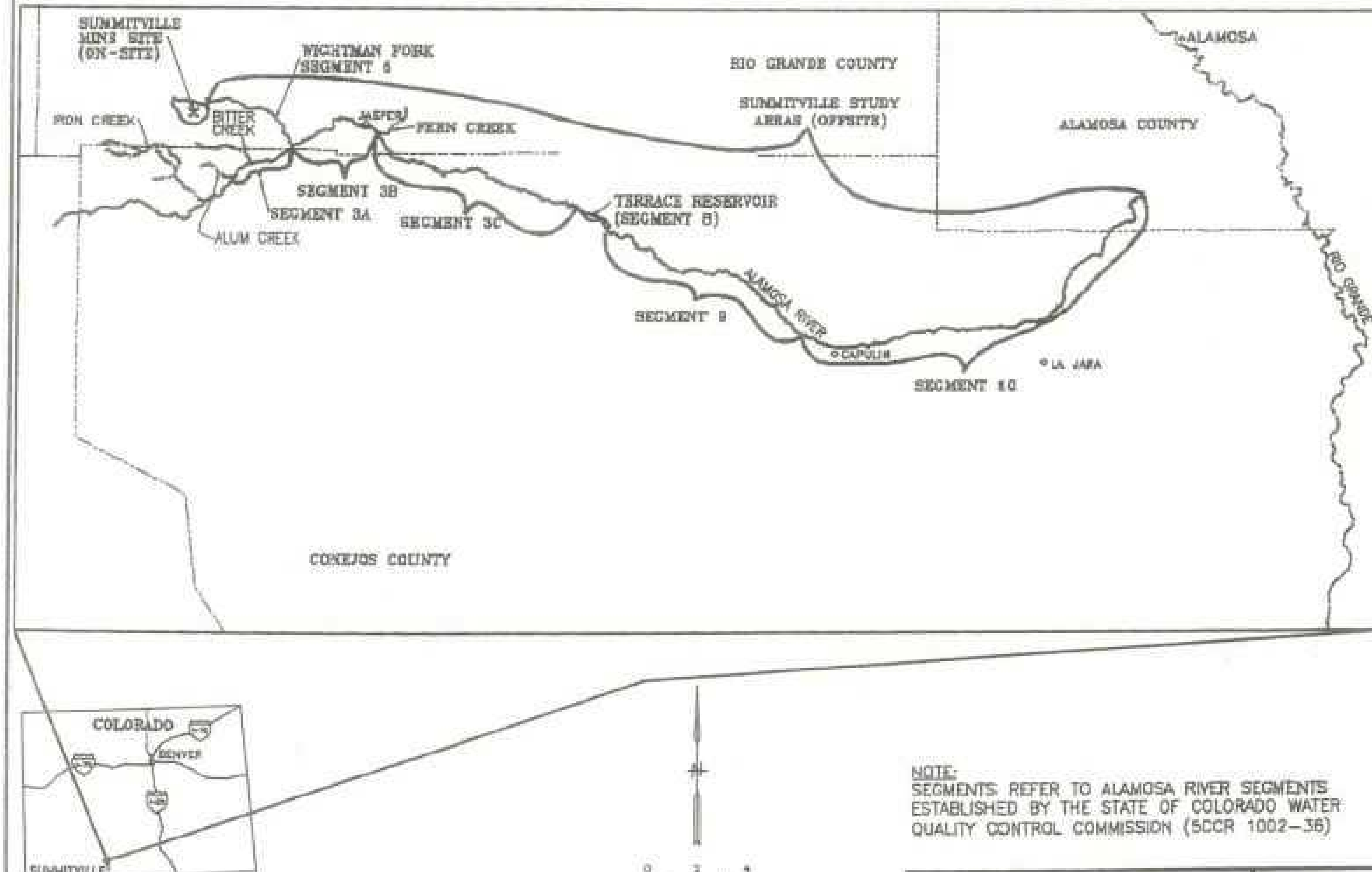
DESCRIPTION	QTY	UNIT	UNIT COST	Net Present Value (4.2%)	TOTAL
Site Monitoring					
Surface Water (years 10 - 100)	2	EVENT	$107,000	$1,716,000	
Groundwater (years 10 - 100)	1	EVENT	$54,000	$866,000	
Geotechnical (years 10 - 100)	1	EVENT	$24,000	$385,000	
				SUBTOTAL:	$2,967,000
Grade Roads (Years 10-100)	1	LS	$7,000	$112,000	
Clean and Maintain Ditches(Years 10-100)	1	LS	$30,000	$481,000	
Maintain/Inspect Adits (Years 10-100)	1560	LF	$40	$994,000	
Water Treatment Plant (Years 10-100)	1	LS	$1,119,111	$174,946,000	
				SUBTOTAL:	$19,533,000
Contingency (% sum)	30%			$6,750,000	
				SUBTOTAL:	$29,250,000
Project Management (% sum)	5%				$1,462,500
Technical Support (% sum)	12%				$3,510,000
				SUBTOTAL:	$4,973,000
TOTAL ANNUAL O&M COST					**$34,223,000**

PERIODIC COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	Net Present Value (4.2%)	TOTAL
Reynold Bulkhead Replacement					
33 Year Replacement Interval	1	LS	$500,000	$170,000	
Treatment Plant Replacement					
33 Year Replacement Interval	1	LS	$1,500,000	$511,000	
				SUBTOTAL:	$681,000
Mobilization/Demobilization	5%			$34,050	
				SUBTOTAL:	$715,000
Contingency (% sum)	30%			$214,500	
				SUBTOTAL:	$930,000
Project Management	5%			$46,500	
Remedial Design	6%			$55,800	
Construction Management	6%			$55,800	
				SUBTOTAL:	$158,000
Five Year Review: 5 Years	1	LS	$17,000	$48,000	
Update Site Database: 5 Years	1	LS	$17,000	$48,000	
Water Rights (Project Years 10-100)	15	AC-FT	$8,500	$136,000	
				SUBTOTAL:	$232,000
Project Management (% sum)	5%				$11,600
Technical Support (% sum)	12%				$27,840
				SUBTOTAL:	$39,000
TOTAL PERIODIC COST					**$1,359,000**
TOTAL PRESENT VALUE OF LONG-TERM O&M:					**$35,582,000**

(All subtotal and total costs rounded to nearest $1000)

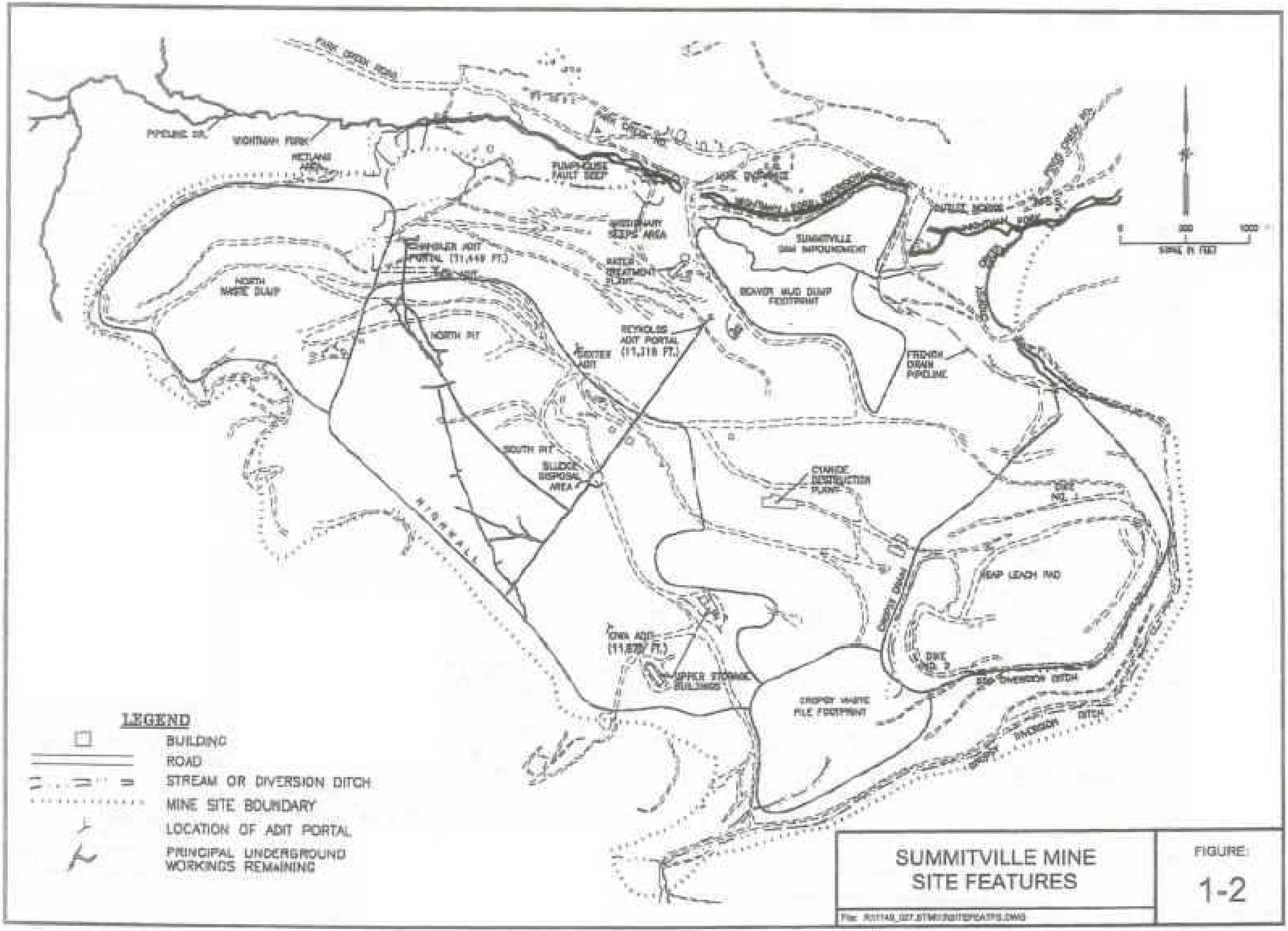
FIGURES



NOTE:
SEGMENTS: REFER TO ALAMOSA RIVER SEGMENTS ESTABLISHED BY THE STATE OF COLORADO WATER QUALITY CONTROL COMMISSION (5CCR 1002-36)

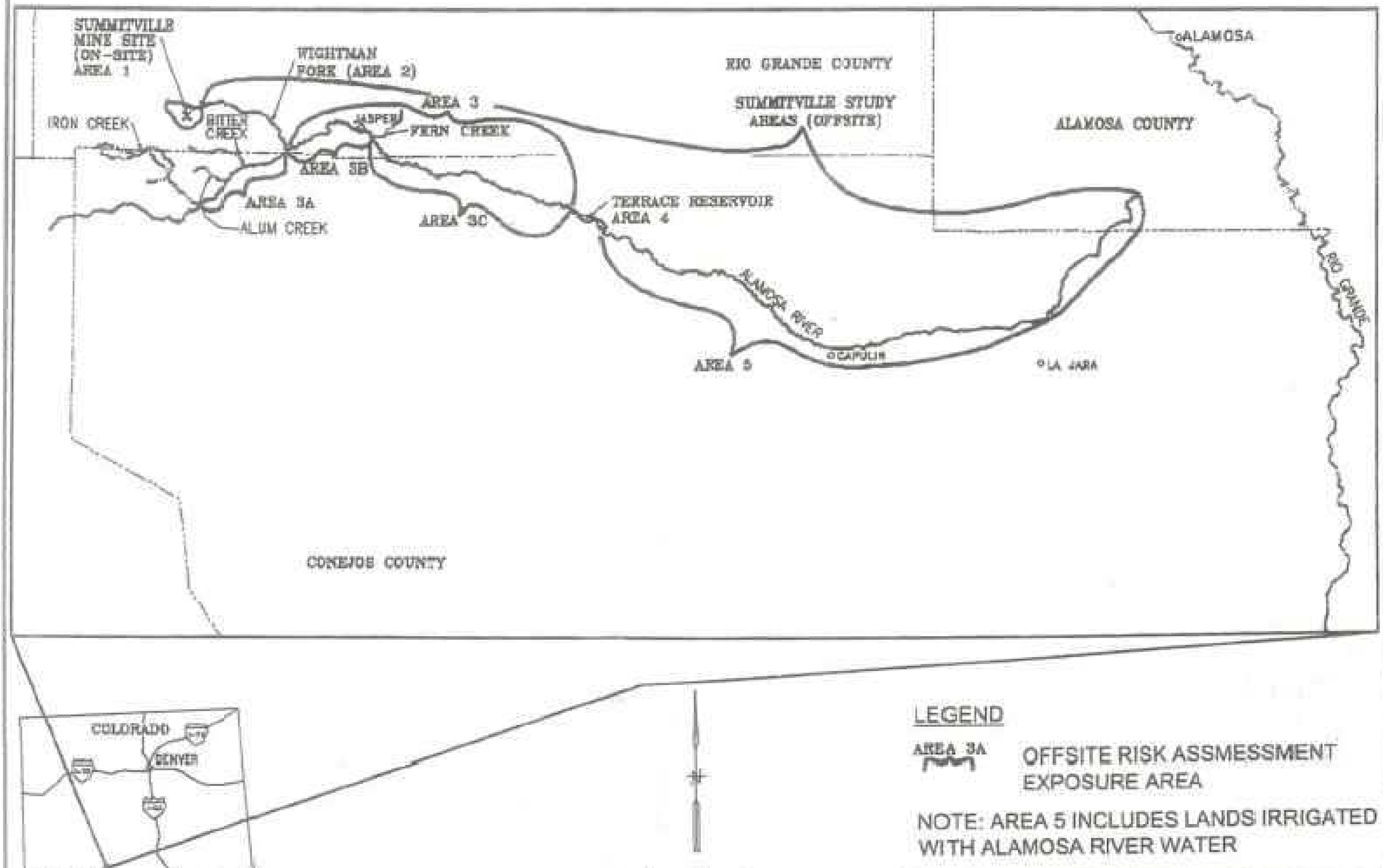
SITE LOCATION

FIGURE: 1-1



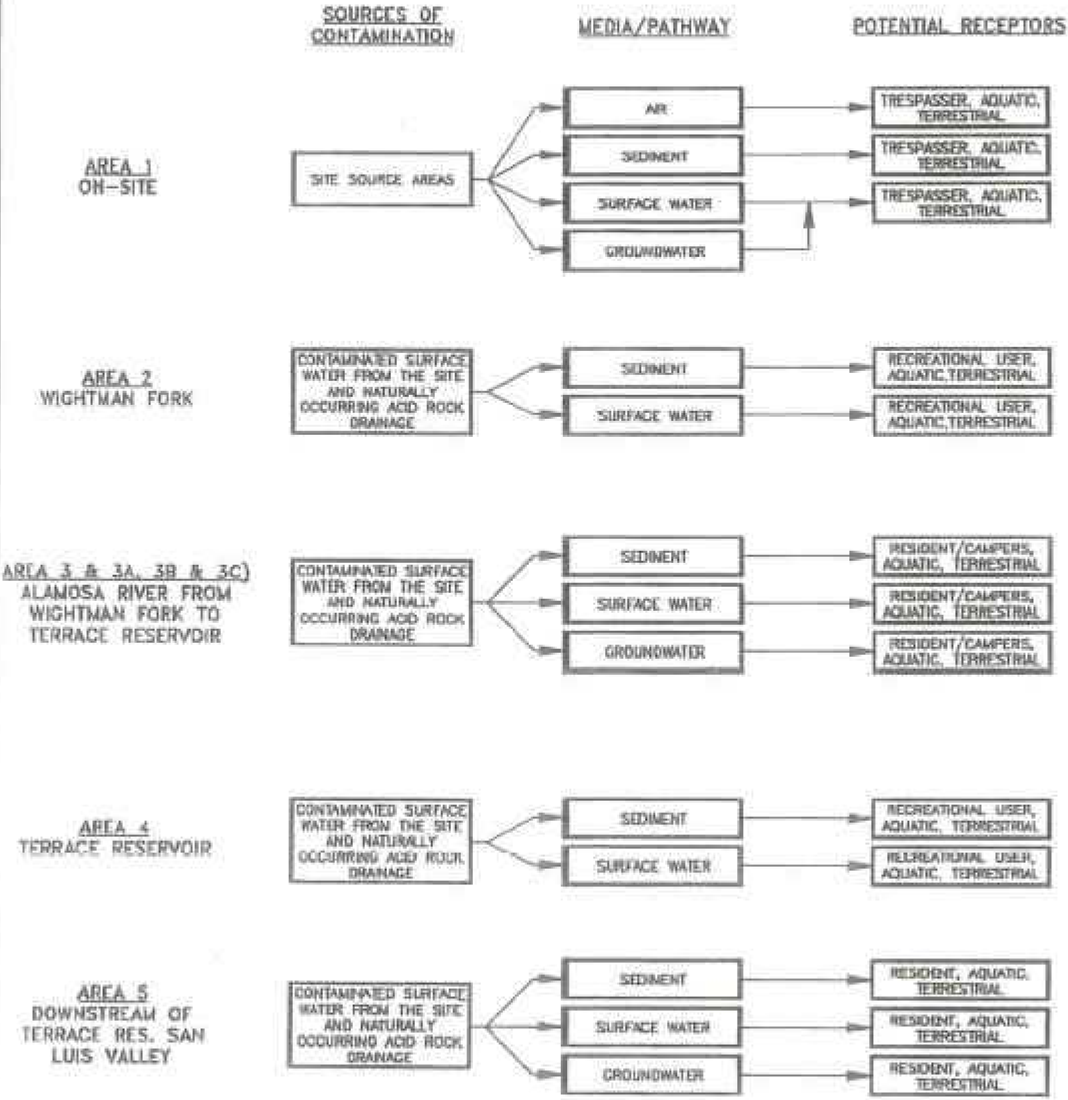
SUMMITVILLE MINE SITE FEATURES

FIGURE: 1-2



EXPOSURE AREAS USED FOR HUMAN HEALTH & ECOLOGICAL RISK ASSESSMENT

FIGURE: 2-1



AQUATIC– RAINBOW TROUT AND MACROINVERTEBRATES

TERRESTRIAL– ELK, SHEEP, MEADOW VOLE, BEAVER, DUCKS, AND GEESE

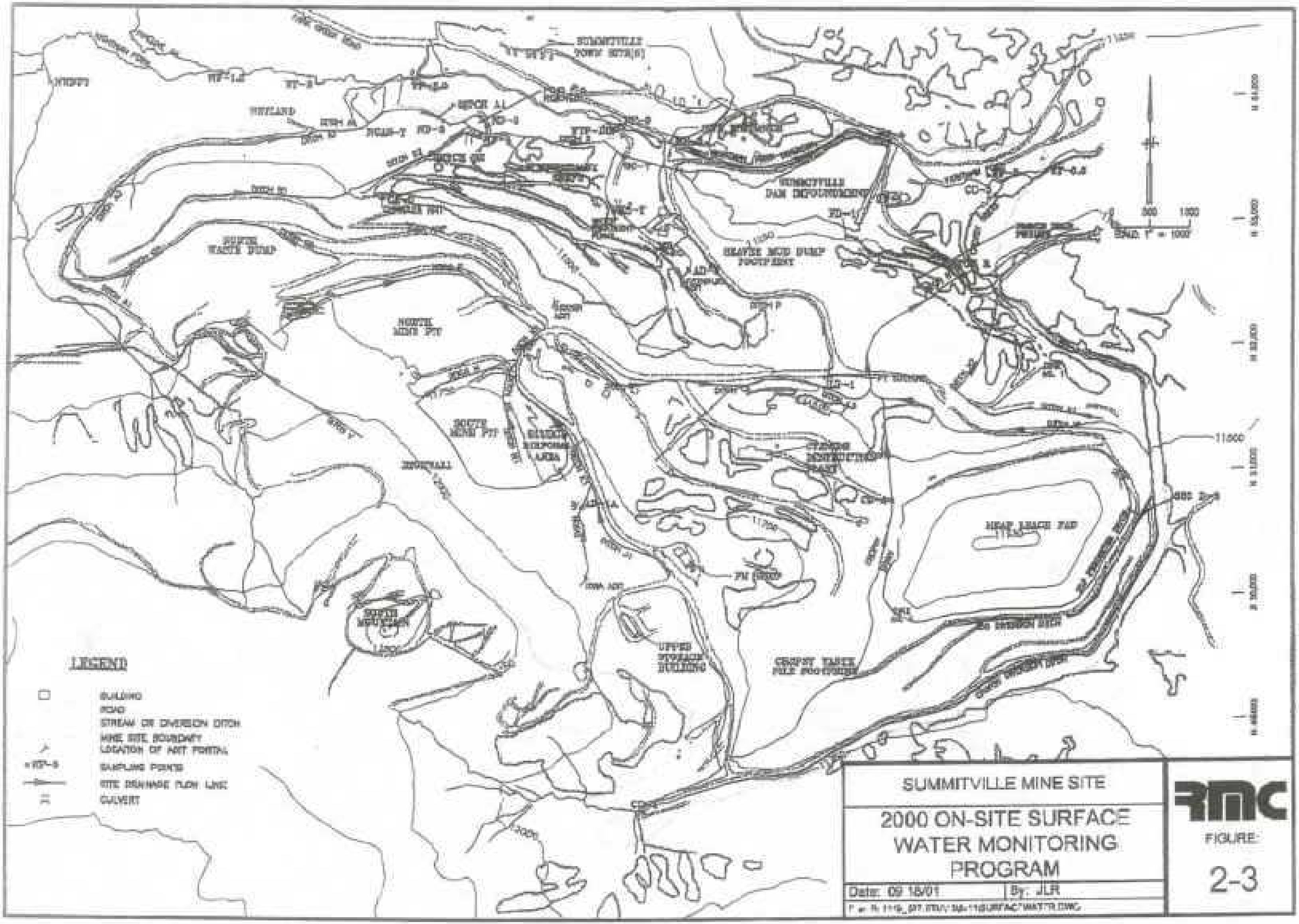
SUMMITVILLE MINE SITE-WIDE RI/FS

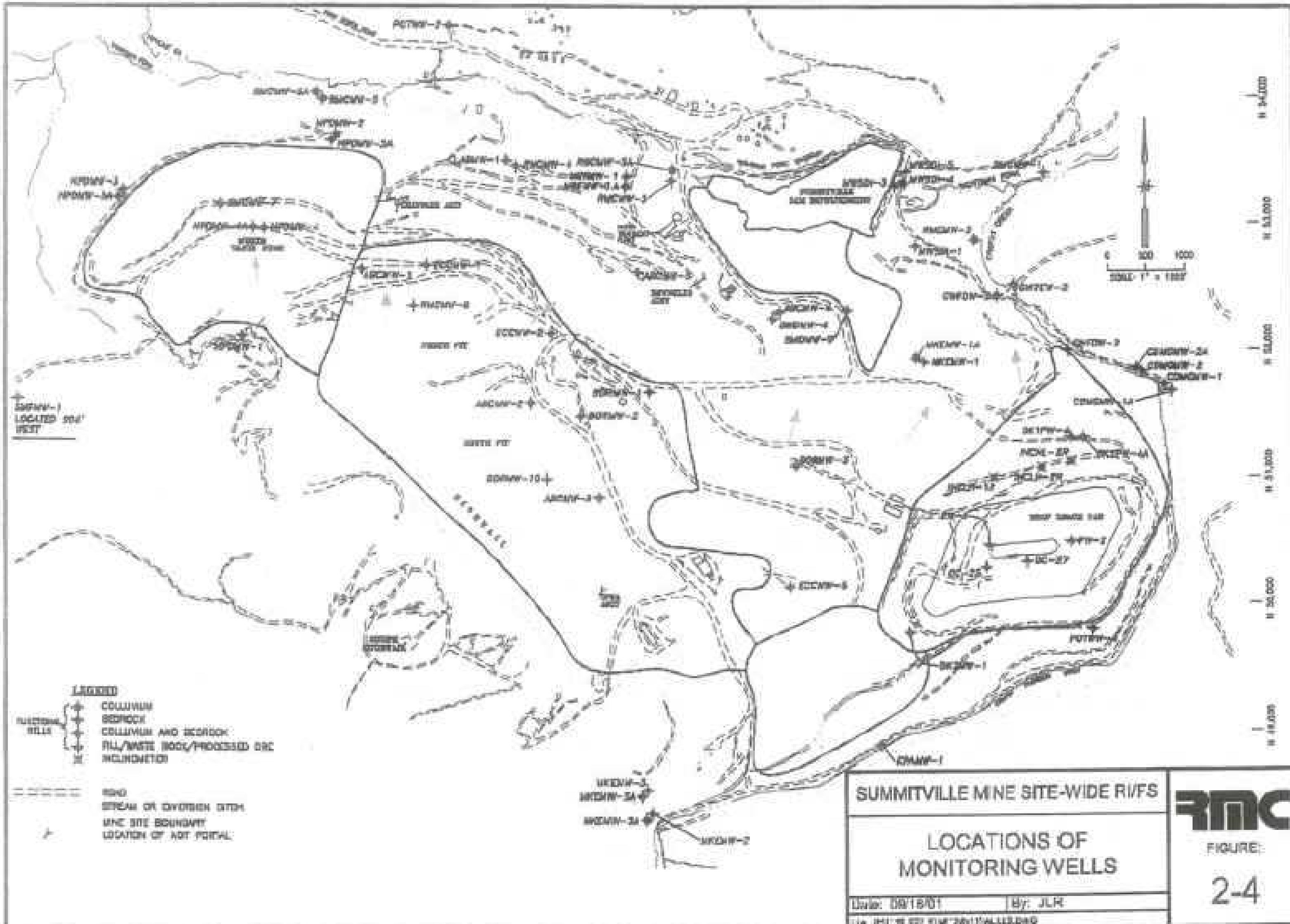
CONCEPTUAL MODEL OF SUMMITVILLE MINE SITE AND DOWNSTREAM STUDY AREAS

Date: 08/22/01 By: DJH

RMC

FIGURE: 2-2

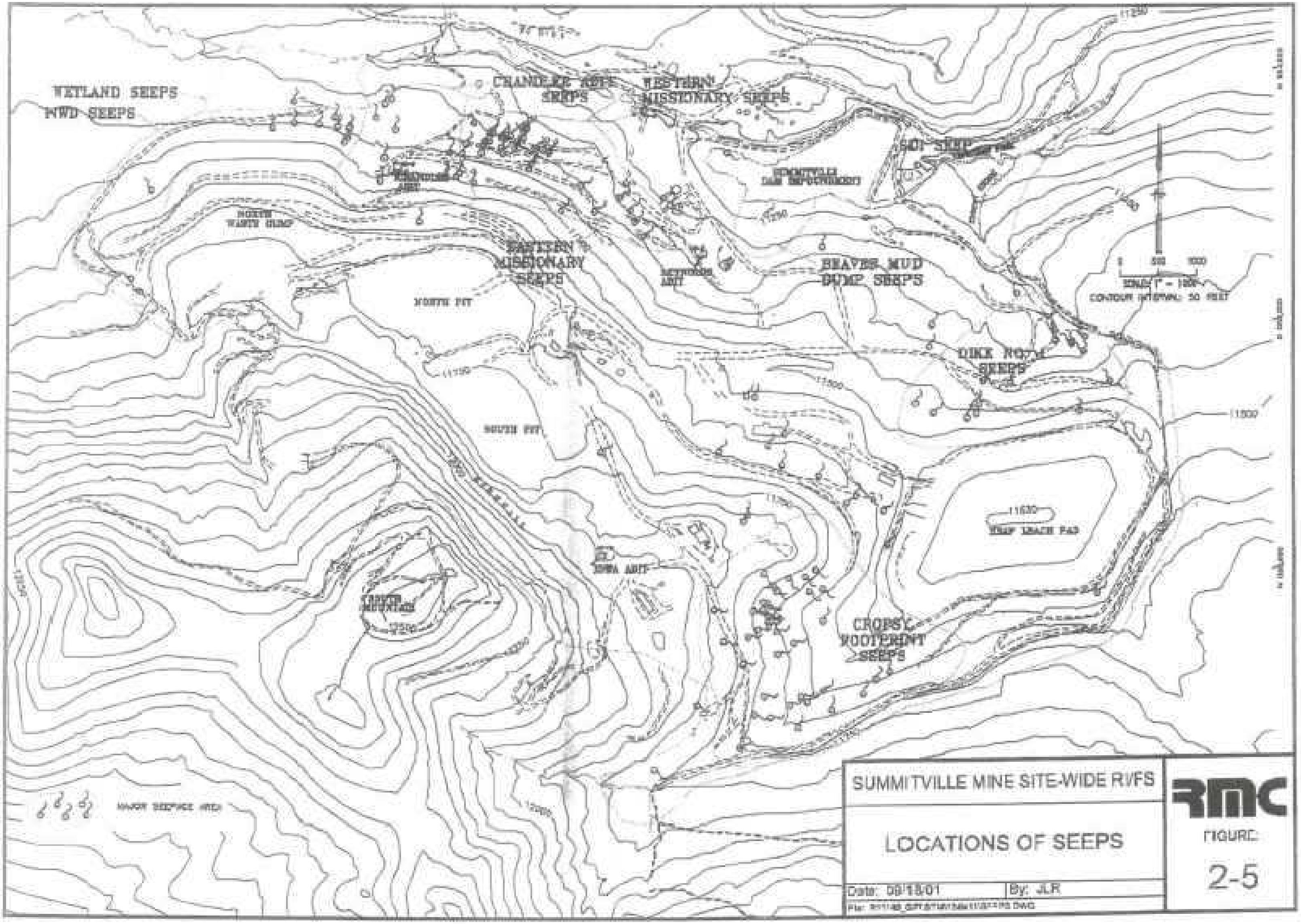

SUMMITVILLE MINE SITE
2000 ON-SITE SURFACE WATER MONITORING PROGRAM
Date: 09 18/01
By: JLR
FIGURE:
2-3
LEGEND
BUILDING
ROAD
STREAM OR DIVERSION DITCH
MINE SITE BOUNDARY
LOCATION OF ADIT PORTAL
SAMPLING POINTS
SITE DRAINAGE FLOW LINE
CULVERT
WETLAND
NORTH WASTE DUMP
NORTH MINE PIT
SOUTH MINE PIT
SUMMITVILLE DAM IMPOUNDMENT
HEAP LEACH PAD
UPPER STORAGE BUILDING
11000



SUMMITVILLE MINE SITE-WIDE RI/FS

LOCATIONS OF MONITORING WELLS

FIGURE: 2-4



SUMMITVILLE MINE SITE-WIDE RI/FS

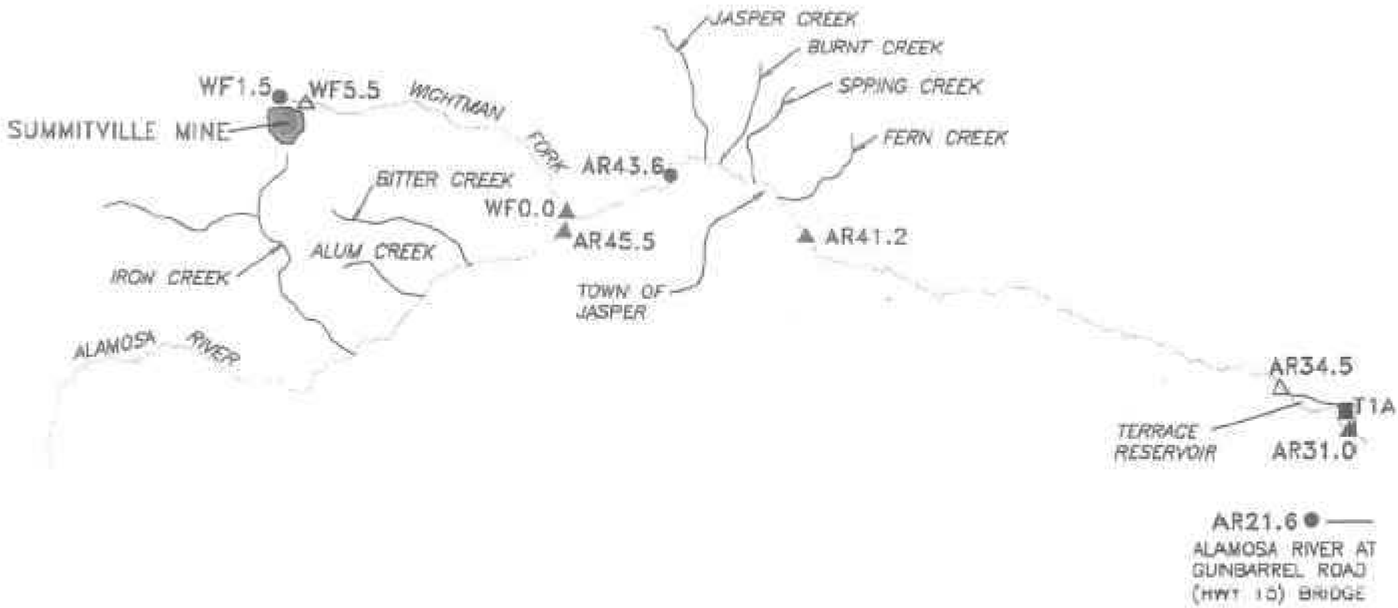
LOCATIONS OF SEEPS

Date: 08/15/01 | By: JLR

RMC

FIGURE

2-5



△ WF — ROUTINE SURFACE WATER MONITORING SITE WITH SEASONAL CONTINUOUS FLOW GAGING

▲WF0.0 — ROUTINE SURFACE WATER MONITORING SITE WITH SEASONAL CONTINUOUS FLOW GAGING, pH, SPECIFIC CONDUCTANCE AND TEMPERATURE MONITORING

● — ROUTINE SURFACE WATER MONITORING SITE WITH NO INSTRUMENTATION

■ — ROUTINE RESERVOIR MONITORING SITE

N

NOT TO SCALE

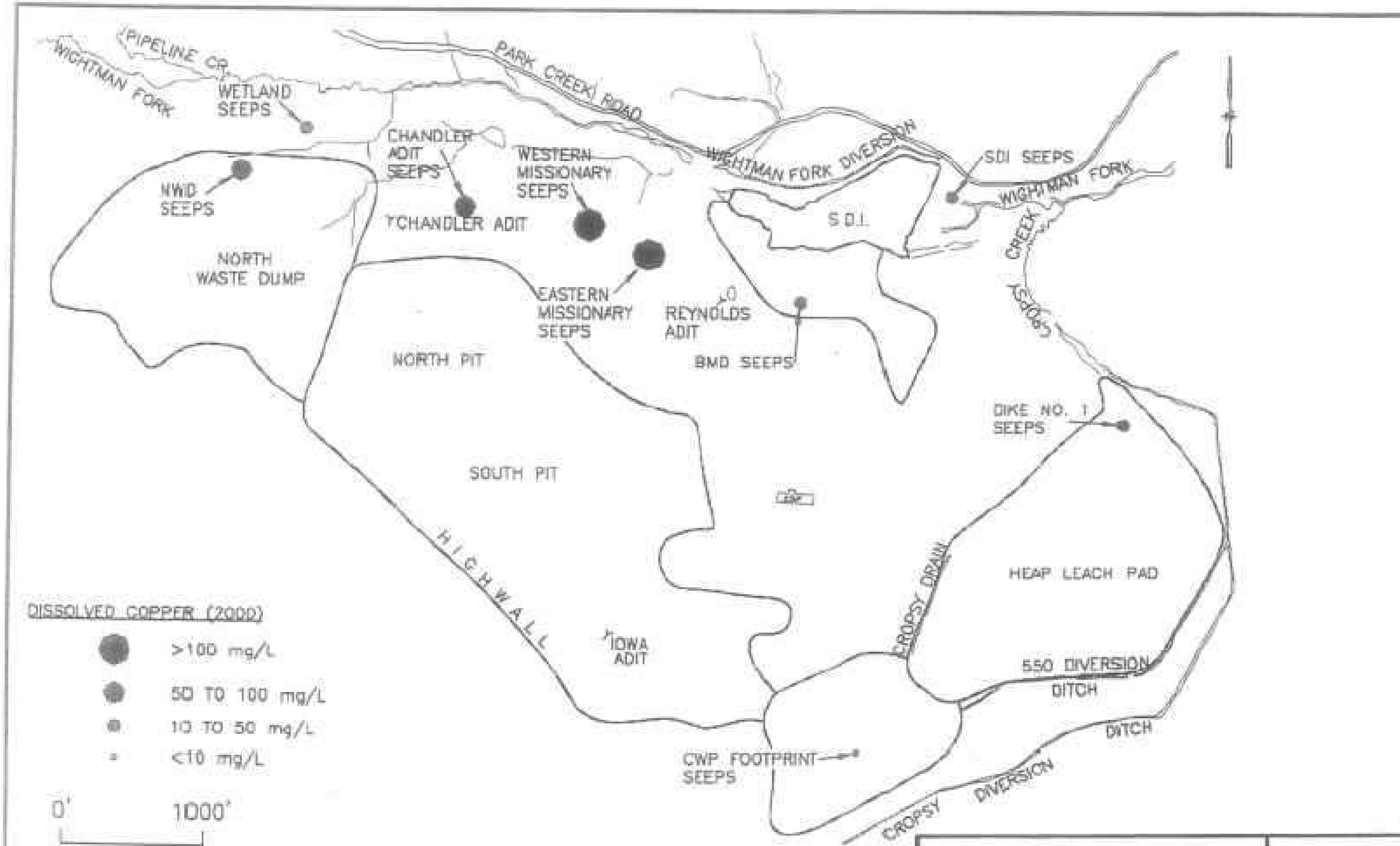
SUMMITVILLE MINE SITE-WIDE RI/FS

2000 NETWORK OF OFFSITE SURFACE WATER MONITORING SITES

Date: 08/24/01 | By: DJH

RMC

FIGURE: 2-6



NOTE:
DOTS REPRESENT AVERAGE CONCENTRATION AMONG SEEPS IN THE AREA

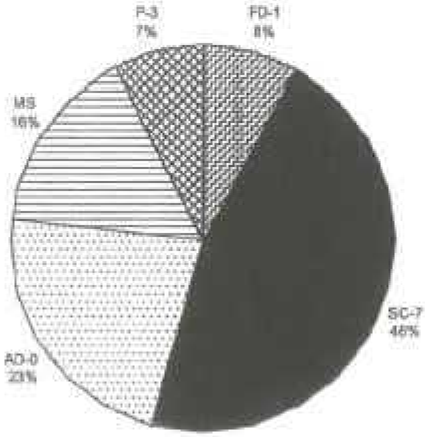
SUMMITVILLE MINE SITE-WIDE RI/FS

RMC

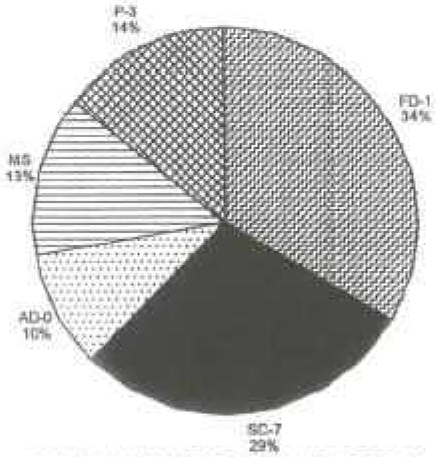
DISSOLVED COPPER CONCENTRATIONS AT MAJOR SEEPAGE AREAS

FIGURE: 2-7

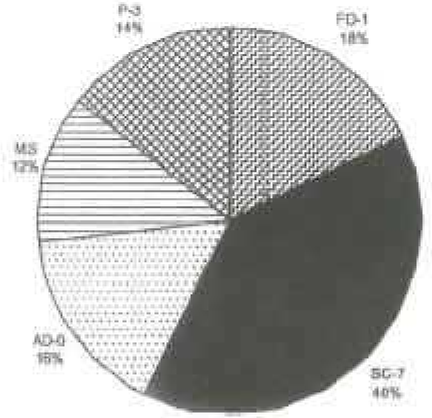
Date: 08/24/01 By: DJH



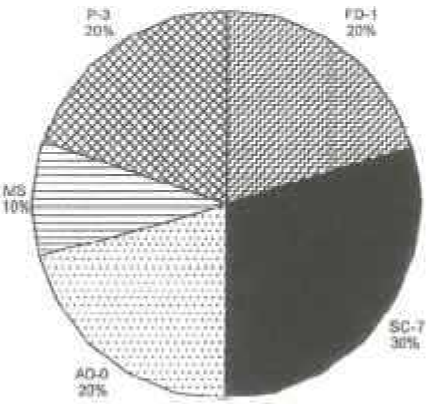
TOTAL COPPER LOAD: 302 LBS/DAY



TOTAL MANGANESE LOAD: 163 LBS/DAY



TOTAL ZINC LOAD: 98 LBS/DAY



TOTAL IRON LOAD: 1,470 LBS/DAY

KEY

SAMPLE LOCATIONS ARE:

FD-1 = FRENCH DRAIN PIPE AT THE SDI

SC-7 = POND 6 DISCHARGE, INCLUDING CHANDLER ADIT (CA-0) FLOWS

AD-0 = REYNOLDS ADIT

MS = SURFACE RUNOFF BETWEEN REYNOLDS AND CHANDLER ADITS

P3 = SUM OF CDP AND SC-3-RI TO MODEL HISTORIC FLOWS FROM POND 3

*AVERAGE OF SAMPLES COLLECTED: MAY 18-NOV. 8, 1999

*METALS ARE TOTAL RECOVERABLE FORM

SUMMITVILLE MINE SITE-WIDE RI/FS
Remedial Investigation Report

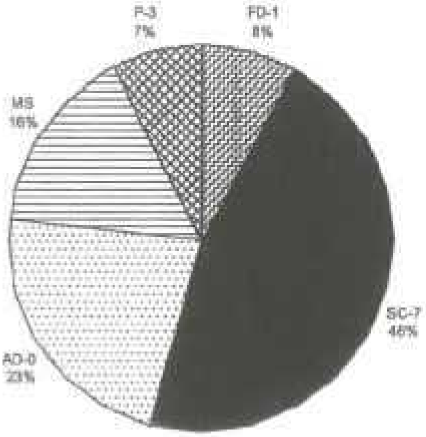
SUMMARY OF SDI 1999
LOADING SOURCES

Date: 09/18/01 | By: JLR

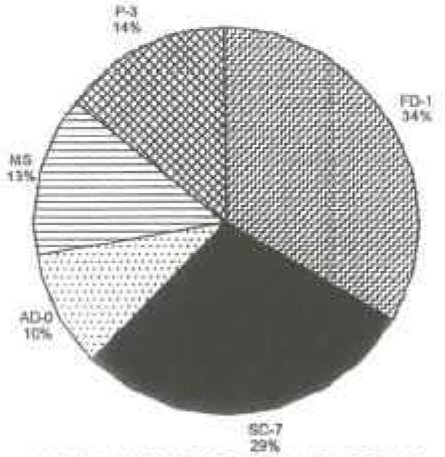
RMC

FIGURE:

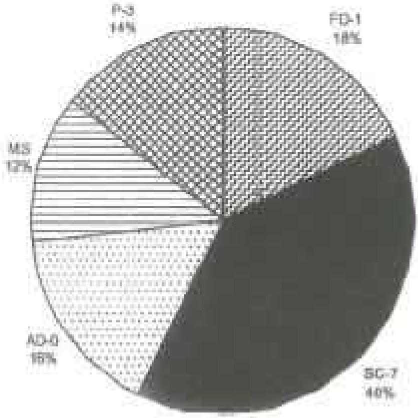
2-8



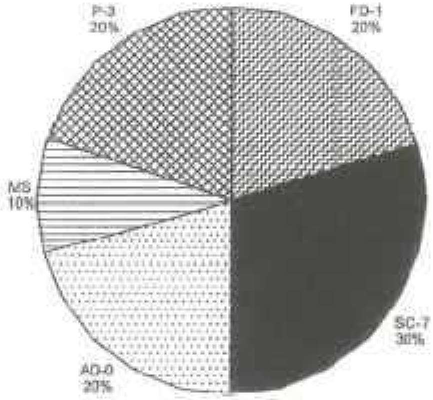
TOTAL COPPER LOAD: 302 LBS/DAY



TOTAL MANGANESE LOAD: 163 LBS/DAY



TOTAL ZINC LOAD: 98 LBS/DAY



TOTAL IRON LOAD: 1,470 LBS/DAY

KEY

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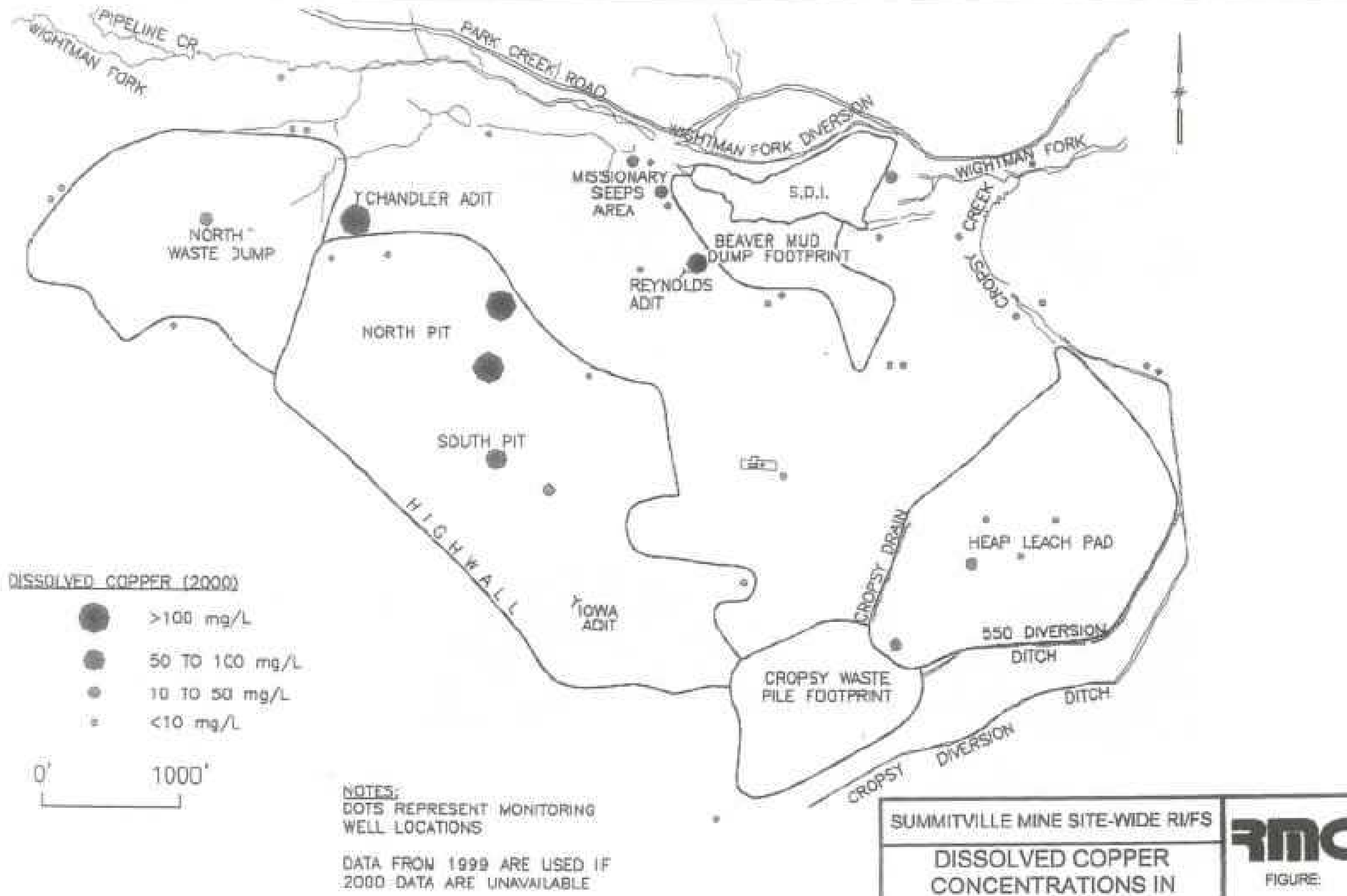
SUMMITVILLE MINE SITE-WIDE RI/FS
Remedial Investigation Report

SUMMARY OF SDI 1999
LOADING SOURCES

Date: 09/18/01 By: JLR

FIGURE:

2-8



SUMMITVILLE MINE SITE-WIDE RI/FS

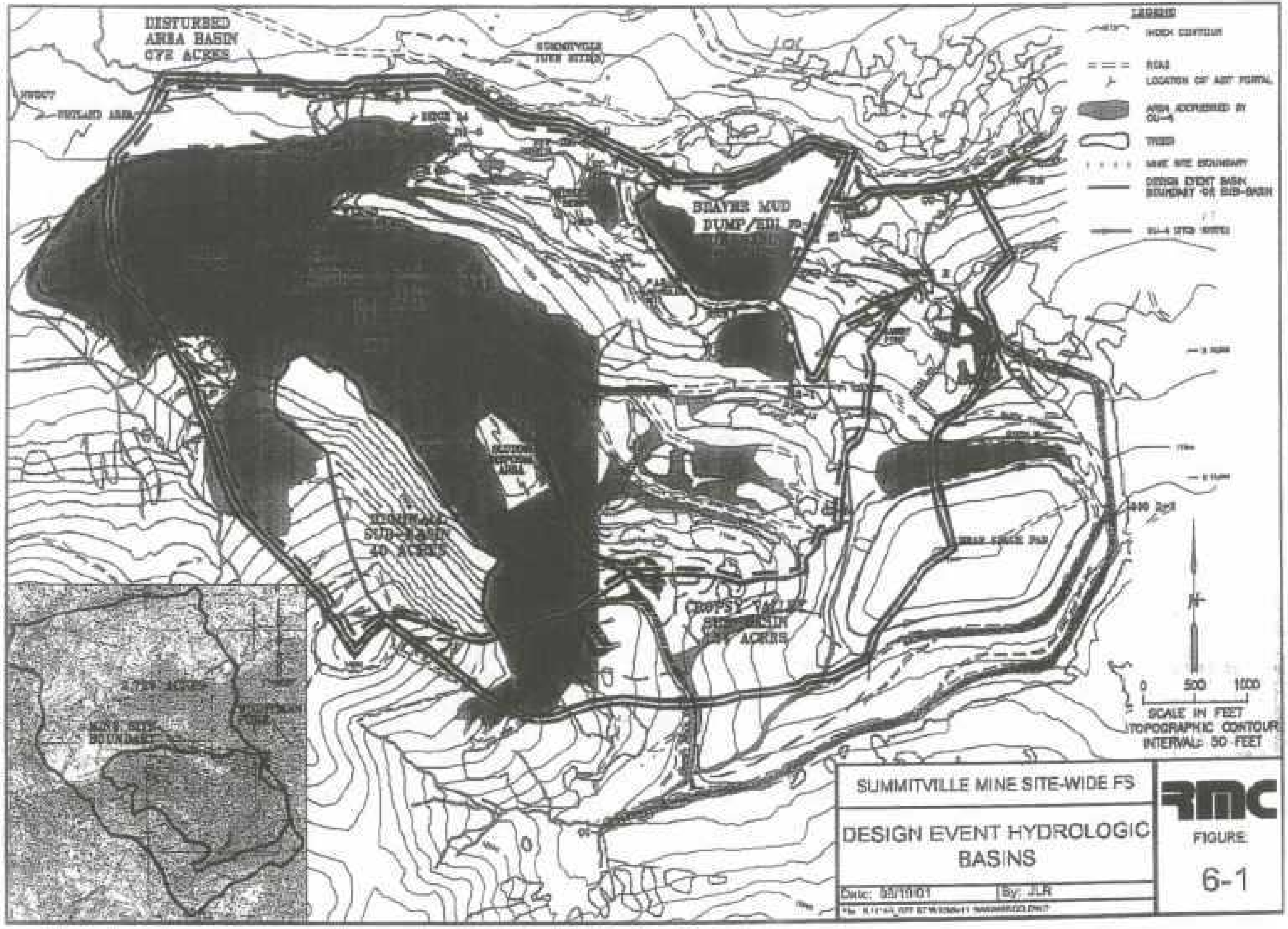
DISSOLVED COPPER CONCENTRATIONS IN GROUNDWATER

Date: 08/24/01 | By: DJH

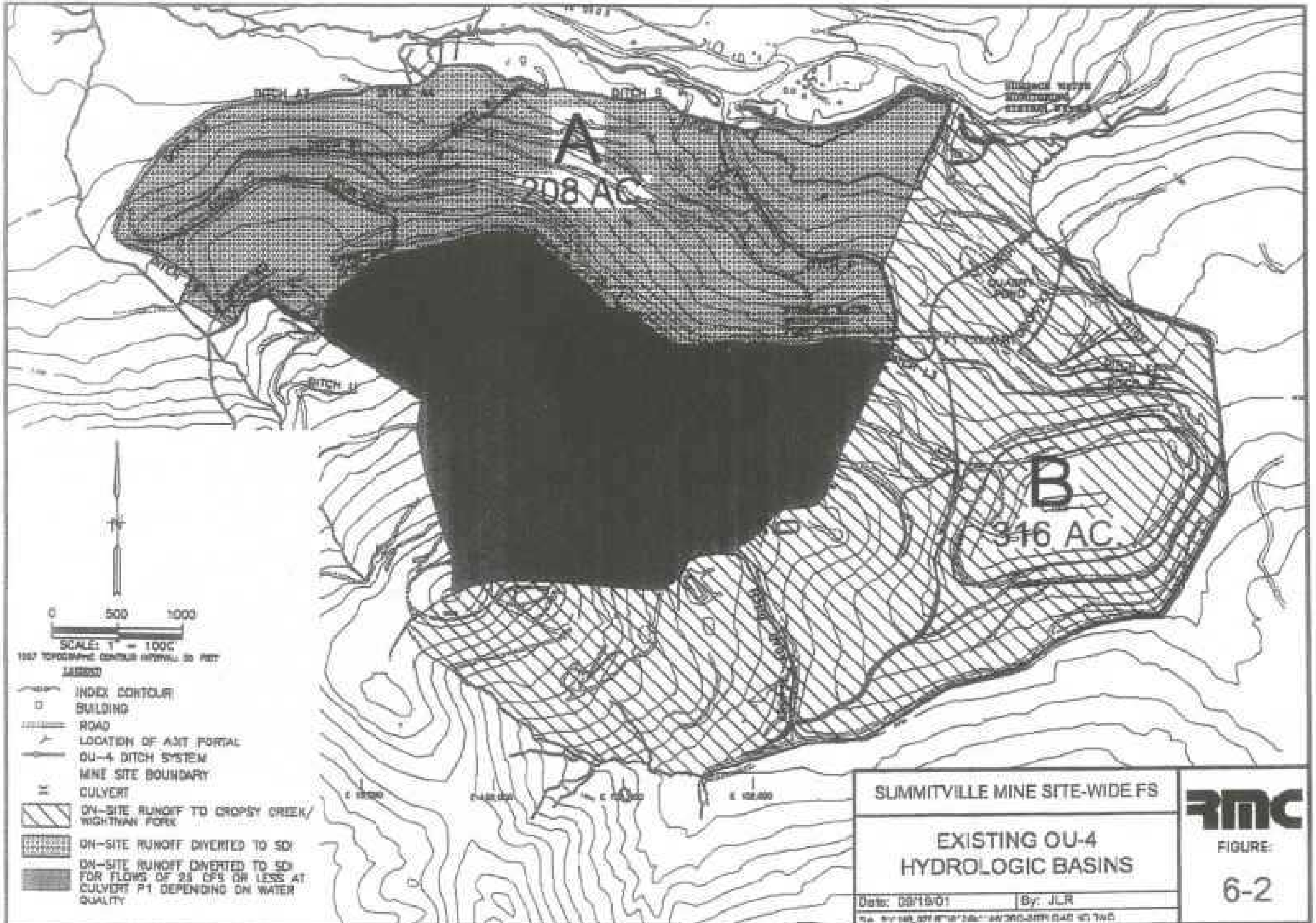
File: R11149_027.STM\SITESCHEMATIC.DWG

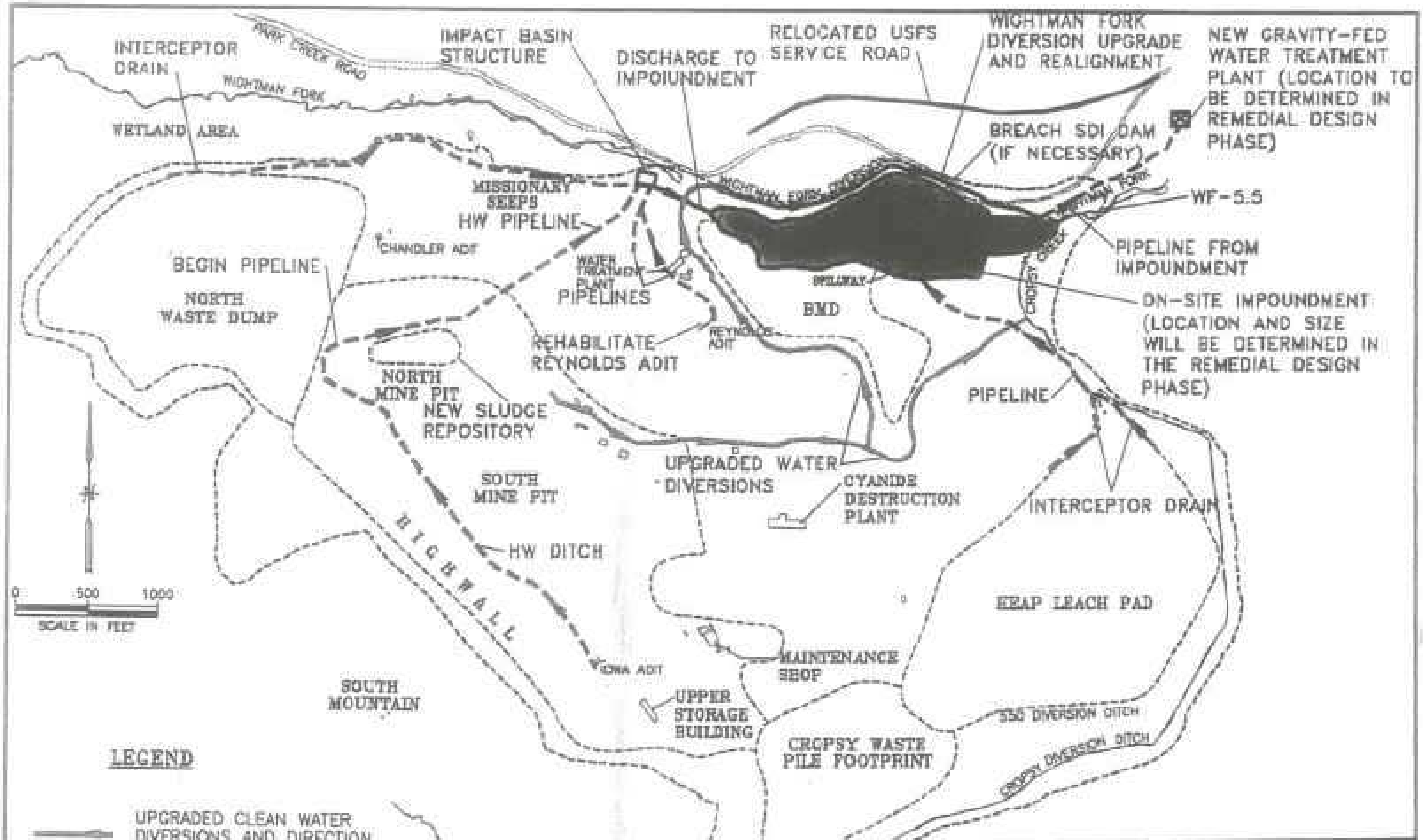
RMC

FIGURE: 2-10

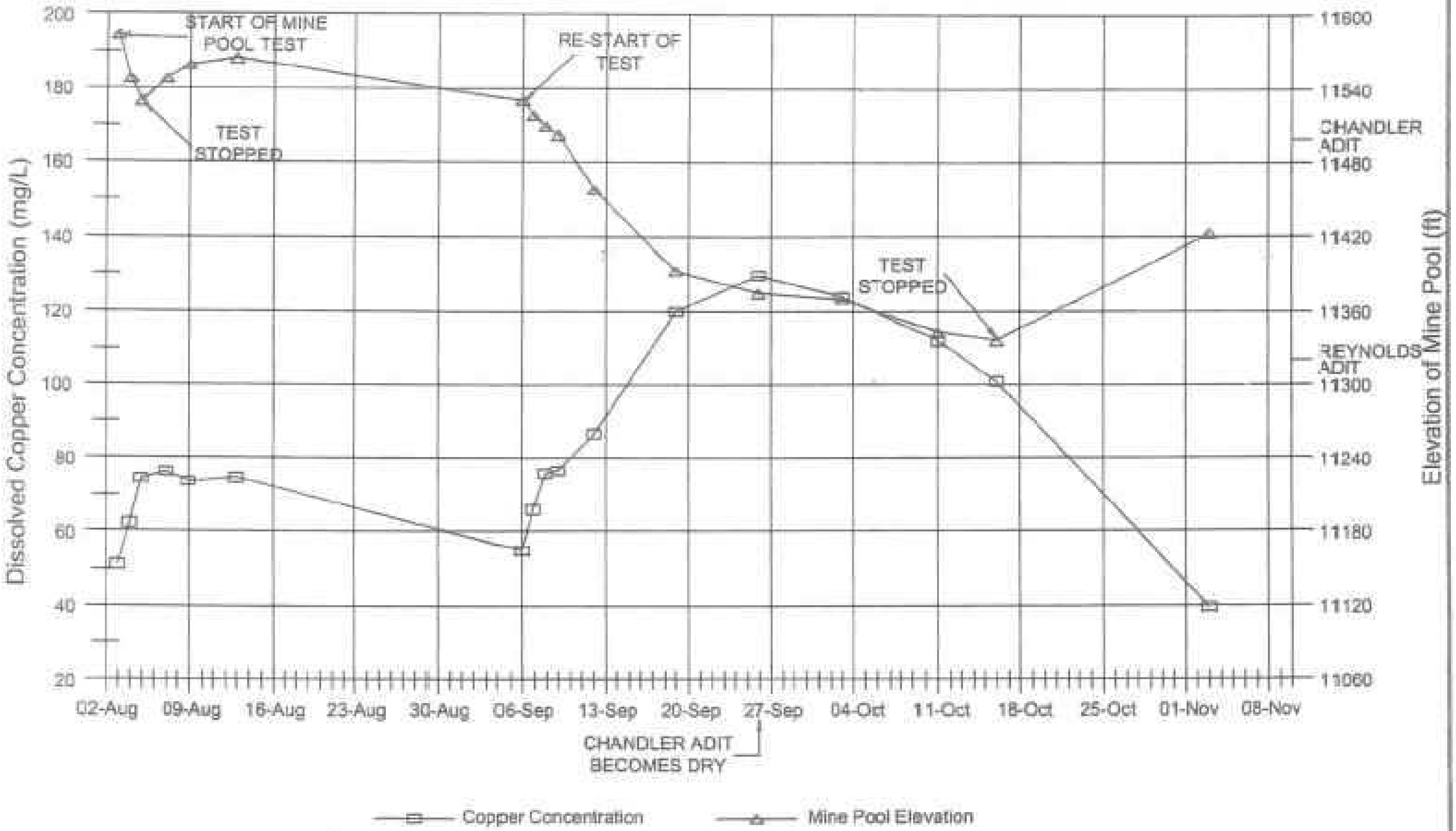


DISTURBED AREA BASIN
BEAVER MUD DUMP/SUB-
0 500 1000
SCALE IN FEET
TOPOGRAPHIC CONTOUR INTERVAL: 50 FEET
SUMMITVILLE MINE SITE-WIDE FS
DESIGN EVENT HYDROLOGIC BASINS
RMC
FIGURE
6-1


A
208 AC
B
316 AC.
DITCH A3
DITCH A4
DITCH B
DITCH U
0
500
1000
SCALE: 1" = 100C
INDEX CONTOUR
BUILDING
ROAD
LOCATION OF ADIT PORTAL
OU-4 DITCH SYSTEM
MINE SITE BOUNDARY
CULVERT
ON-SITE RUNOFF TO CROPSY CREEK/ WIGHTMAN FORK
ON-SITE RUNOFF DIVERTED TO SDI
ON-SITE RUNOFF DIVERTED TO SDI FOR FLOWS OF 25 CFS OR LESS AT CULVERT P1 DEPENDING ON WATER QUALITY
SUMMITVILLE MINE SITE-WIDE FS
RMC
EXISTING OU-4 HYDROLOGIC BASINS
FIGURE:
6-2
Date: 08/18/01
By: JLR



SUMMITVILLE MINE SITE-WIDE RI/FS	RMC
COMPONENTS OF SELECTED REMEDY	FIGURE: 7-1
Date: 09/21/01 By: JLR	



NOTE:
SAMPLED AT REYNOLDS ADIT PIPELINE

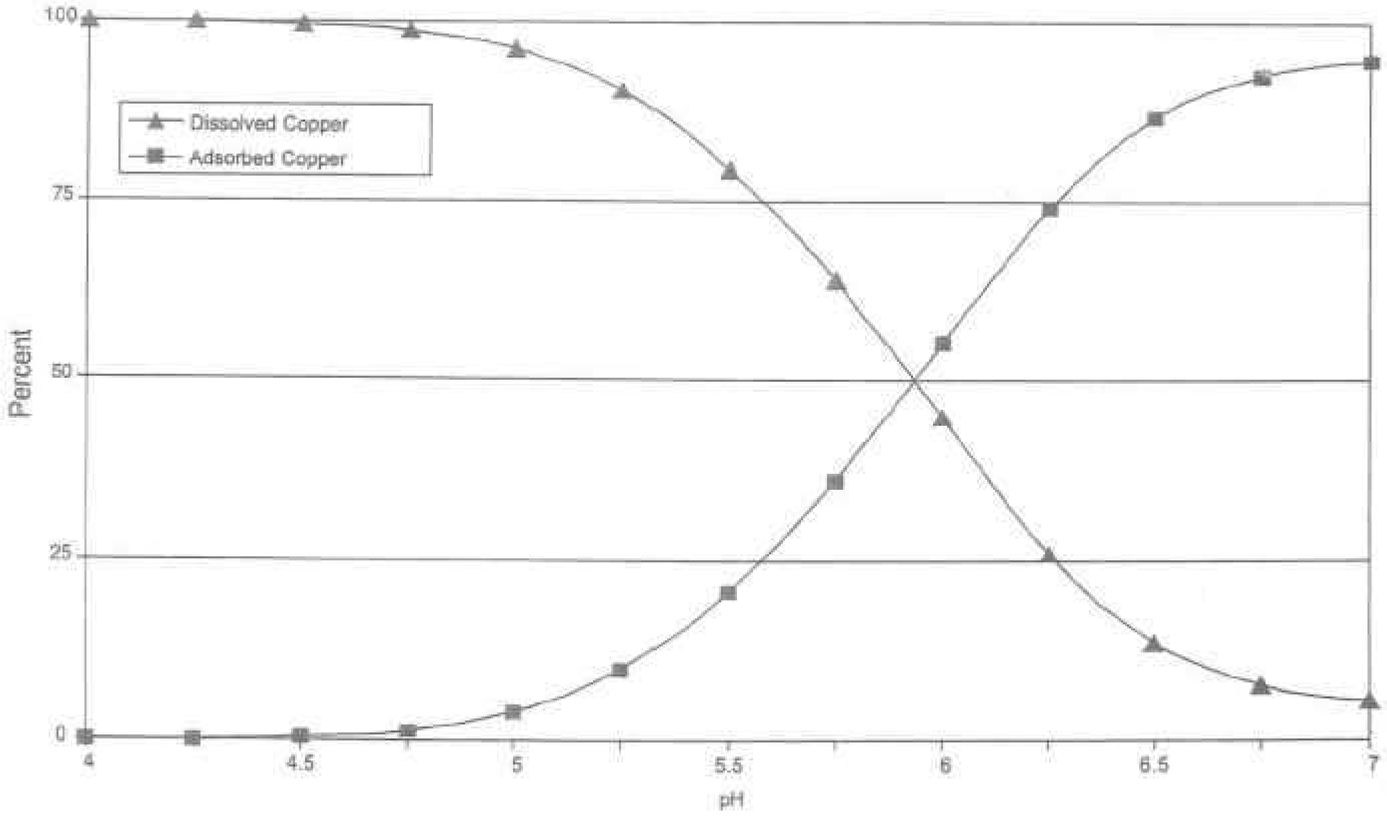
SUMMITVILLE MINE SITE-WIDE RI/FS
Remedial Investigation Report

CONCENTRATION OF COPPER AND MINE POOL ELEVATION DURING 2000 MINE POOL TEST

Date: 09/21/01 | By: JLR

RMC

FIGURE:
7-2



NOTE:
DISTRIBUTION OF COPPER DETERMINED USING MINTEQA2.
ALTERNATIVE 5 LOW FLOW CONCENTRATIONS FOR
STATION AR41.2 USED AS INPUT.

SUMMITVILLE MINE SITE-WIDE RI/FS	RMC
DISTRIBUTION OF DISSOLVED AND ADSORBED (PARTICULATE) COPPER AS FUNCTION OF pH IN SEGMENT 3c	FIGURE: 7-3
Date: 09/27/01 By: JLR	